Ontario Assessment Instrument Pool

Junior Division Science

Assessment Planning Guide

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Junior Division Science OAIP

ASSESSMENT PLANNING GUIDE

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Assessment Planning Guide

Life Science

Plants and Animals in the Environment, Part 1
Plants and Animals in the Environment, Part 2
Plants and Animals in the Environment, Part 3
Plants and Animals in the Environment, Part 4
Plants and Animals in the Environment, Part 5
People in the Environment
The Human Body

Earth and Space Science

The Earth
The Atmosphere, Part 1
The Atmosphere, Part 2
The Atmosphere, Part 3
Time and Time Relationships
Earth, Sun, and Moon, Part 1
Earth, Sun, and Moon, Part 2

Physical Science

Materials and Substances, Part 1
Materials and Substances, Part 2
Materials and Substances, Part 3
Measurement
Cause and Effect Relationships
Machines
Energy, Part 1
Energy, Part 2
Energy, Part 3
Energy Resources and the Environment

OAIP Ontario Assessment Instrument Pool

Junior Division Science OAIP

ASSESSMENT PLANNING GUIDE

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Ontario

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An OAIP subject pool is usually created for the Ministry of Education and Training by a contractor, with the project being managed for the contractor by one or more principal developers and the instruments being written by the principal developers and a team of writers, usually teachers and/or subject co-ordinators/consultants. The development of the Junior Division Science OAIP was a co-operative venture with la Banque d'Instruments de Mesure de l'Ontario (BIMO), the French-language equivalent of OAIP. BIMO developed the **Life Science** materials and OAIP created the **Earth and Space Science** and **Physical Science** instruments. The OAIP contractor was the Science Co-ordinators and Consultants' Association of Ontario. The principal developer for SCCAO was Michael Harrison of the Ottawa Board of Education. The BIMO contractor and principal developer was Gisèle Myre of Ottawa.

For each OAIP project, the Ministry establishes a subject advisory group which reviews the material created by the contractor's team and recommends the rejection, revision, or acceptance of each individual strategy or instrument, in accordance with its suitability for programs based on the relevant curriculum guidelines. The subject advisory group examines the pool as a whole, to ensure comprehensive and appropriate coverage of the curriculum guidelines. It also provides advice on the organization, content, format, and implementation of the pool. The BIMO SAG reviewed and revised the **Life Science** instruments, and, after translation into English by Françoise Lampard, the OAIP SAG reviewed them again and undertook further revisions and additions.

The subject advisory group is representative of teachers, consultants/co-ordinators, and administrators across the province, with representatives of the Ontario Teachers' Federation and the appropriate subject associations. The following people served on the OAIP subject advisory group for the **Junior Division Science**:

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INTRODUCTION

OAIP/BIMO

The Ontario Assessment Instrument Pool/Banque d'instruments de mesure de l'Ontario (OAIP/BIMO) is an extensive collection of assessment/evaluation materials, designed for use primarily in elementary and secondary schools for instructional and evaluation purposes. The materials include assessment and evaluation approaches, strategies, and instruments, and are organized in subject pools, each covering a specific subject/division combination, and based on Ontario curriculum guidelines and other curriculum documents. These subject pools are published in both English and French.

The new OAIP/BIMO subject pools are providing materials which will help the classroom teacher to base student evaluation on more than tests and examinations. They are not test banks. They de-emphasize paper-and-pencil testing and encourage observation as a major assessment technique. They provide a wide variety of assessment and evaluation approaches, strategies, and instruments which assess knowledge, skills, and attitudes, and they focus on both product and **process**. They will help teachers to integrate their assessment into the curriculum, and to base their evaluation on the progress as well as the specific achievements of the student whose work is being evaluated.

Assessment and Evaluation Defined

For the purposes of OAIP/BIMO, the terms **assessment** and **evaluation** are assumed to have specific meanings. **Assessment** is the gathering, recording, and analysis of data, about a student's progress and achievements, or about a program's implementation and effectiveness. **Evaluation** is the application of judgment to the data gathered and its analysis, in order to place a "value" on progress or achievement or effectiveness.

The Purposes of Assessment and Evaluation

Assessment is undertaken to provide a base of information on which to determine what a student or a group of students is capable of or has learned, to identify the strengths and needs of the student or class. This enables the teacher to make informed decisions about the program, to determine whether or not the original objectives and approach were appropriate, and to make modifications so that the program satisfies the needs of individual students and the class as a whole. This need to assess progress is important for **all** students and classes, in all grades, and in all types of programs.

Assessment also enables the teacher to maintain a record of each student's progress and achievements, which can be used to produce informative reports for parents and others concerned with a student's progress.

The Importance of Assessment and Evaluation

The importance of **effective** assessment and evaluation cannot be over-emphasized. Assessment and evaluation provide information and judgments about student progress and achievements and about the effectiveness of program, but the ultimate purpose of assessment and evaluation is to improve learning.

Learning may be improved because programs are improved as a result of the interpretation and application of information derived from assessment activities, and also by several indirect results of good assessment approaches. The careful analysis of information gathered through assessment activities will increase the teacher's awareness of the individual differences from one student to another, and will help the teacher to avoid generalizations and find a variety of ways of helping each student achieve progress with the curriculum. This will also help the teacher to assess his or her own teaching from time to time in relation to the needs of the students. Improved communication between teacher and student will also result from the teacher's deeper understanding of the individual student.

To achieve effective assessment, the teacher must ensure that the students know **what** is being assessed and **how**, and especially **why**. Whenever possible, students should be involved in the decision-making related to assessment activities. A student's understanding of assessment and involvement in planning and implementing assessment activities will influence the student's perception of and commitment to learning, and will encourage the development of skill in self-evaluation and personal decision-making.

Types of Assessment and Evaluation

Assessment and evaluation should be integrated into the curriculum, as part of the learning process. This means that assessment is going on, in one form or another, most of the time.

Diagnostic assessment may be undertaken at any time, to determine the current status of a particular student or group of students in relation to a part of the curriculum, in order to decide how much review is necessary or how to approach a new concept or skill. It is usually undertaken, however, at the beginning of a school year or of a unit or topic within the curriculum. It can also be used with individual students for placement purposes, or with a class for selecting resources.

Formative assessment is ongoing assessment. It occurs at any time during a school year or a unit or topic, that is, during the course of learning, to find out whether or not the objectives are being achieved. It is an integral part of the teaching-learning process. Ongoing assessment identifies difficulties quickly and provides an opportunity for immediate remedial action. It may result in changing the teacher's approach to presenting the curriculum (the resource materials or the teaching strategy) or in adjusting an individual student's approach. It provides continuous information about a learner's growth or a class's success with the curriculum and a foundation for further planning. The formative process should be used to encourage students to reflect on their own progress.

Summative assessment and evaluation occur at the end of a unit, course, or program. The purpose is usually to judge the student's achievements in relation to some standard of excellence or in relation to some body of knowledge. The teacher can also use summative evaluation to evaluate program effectiveness.

Types of Assessment Instruments

Evaluation can focus on the student or the program, and can be undertaken for a variety of purposes. Assessment of student achievement can focus on product or process; assessment approaches can assess knowledge or skills or attitudes; assessment instruments can be either objective or subjective.

OAIP/BIMO has a wide variety of assessment strategies and tools, which can be used for a variety of purposes. There are many items which can be used for paper-and-pencil testing, if desired, but there are also many which focus on activities and research projects. Some pools emphasize observation as the major assessment strategy.

In OAIP/BIMO, the term **item** refers only to the question or assignment given to the student. The **instrument** includes the item and all other pieces of information related to the item. These include locational information (where does this instrument/item belong within OAIP/BIMO and within this subject pool), descriptive information (the type of item, its difficulty level, its learning domain, etc.), a suggested response, and sometimes teacher notes.

"Instrument type" may refer to the assessment strategy or to the type of item.

Objective forms of instrument/item usually have a "correct" answer. The student is asked to select the correct or most appropriate response from the options given. **Selected response** items include multiple choice, true/false, and matching, among others. Some OAIP subject pools, especially the language pools, contain none of this form of instrument. Objective items do, however, have a place in assessment. A well-designed **multiple choice** item can be used to measure recognition, comprehension, and the application of a concept. **Matching items** can test the understanding of terminology, factual relationships, and concepts.

Some items depend on a **stimulus**, such as a reading passage, map, picture, diagram, chart, etc., as the basis for the student's response. These items test the student's higher-level knowledge processes and enquiry skills which are not dependent on recall alone.

Short answer items need only a brief answer. They may require the student to fill in a blank or complete a short statement; to do a brief calculation; to label a diagram or map; or to complete a table or chart. These items measure a student's ability to recall, generalize, comprehend, apply knowledge, process information, and perform calculations.

Extended response items may be oral, written, or graphic. They include any type of writing assignment which requires more than a few words; a short or long **essay** response

to a question or problem; the **creation of a map, diagram, chart, or graph**; or an **oral presentation**. The writing folder, the oral language portfolio, or any other collection of a student's work; designing and describing an experiment; or suggesting alternate solutions are extended response items. This type of instrument is useful in measuring originality, creativity, divergent thinking, and the ability to organize and express ideas. It is particularly suitable for parts of any course that suggests independent study as an appropriate strategy of instruction. It encourages students to develop their **communication** skills through undertaking research and organizing and synthesizing a detailed response. The ability to represent structures or relationships in the form of a drawing or diagram is an important communication skill which is frequently assessed in Science and sometimes in Mathematics; this may be called a **draw and label** item.

Science makes use of several kinds of laboratory-related items. **Laboratory or field data analysis** items require the student to analyze data provided, using **communication** skills to organize and synthesize a response. A **laboratory skills exercise** is designed to assess the student's laboratory techniques. A **laboratory problem** item requires the student to solve a problem using laboratory equipment and procedures, to suggest a hypothesis, or to design an experiment to test a given hypothesis. While this type of item is used most frequently in Science, it is also appropriate in Mathematics, Geography, and several other subjects.

Checklists, inventories, questionnaires, and ranking and rating measures can be used by either the student or the teacher. A student response in one of these forms can indicate attitudes and values, interests, and the application of judgment. The teacher can use some of these techniques to record observations of individual students or groups of students.

The use of observation by the teacher is a strongly recommended assessment strategy, emphasized as the major approach in some OAIP subject pools. Over-emphasis on paper-and-pencil testing limits the opportunity afforded the teacher to assess such aspects of a student's program as manipulative skills and attitudes. Activity-based items and assessment approaches provide opportunities for this type of assessment and link the assessment techniques more closely to the curriculum.

The need for assessment and the purposes of assessment remain unchanged throughout the student's elementary and secondary school years, but the types and focus of assessment may vary in emphasis as the child moves from the Formative Years, through the Transition Years, and into the Specialization Years.

The Junior Division Science OAIP

The **Junior Division Science OAIP** is a large and varied collection of assessment instruments which can be used to gather information about student achievement, on an individual and group basis. It also provides information to support curriculum planning. The term *Junior Division* as used in this pool of assessment instruments refers to Grades 4 to 6.

The Junior Science pool is based on *Science Is Happening Here*, the provincial curriculum policy document which presents the philosophy and policy of the Ontario Ministry of Education for Grades 1 to 6 education. Both documents emphasize the importance of participating in activities to develop an understanding of scientific approaches and information. Science programs should encourage the natural curiosity of young children, and their investigative skills. Almost 40 per cent of the instruments in the Junior Science OAIP are activities designed to develop manipulative skills and the ability to draw reasonable conclusions from evidence found.

The curriculum of *Science Is Happening Here* is organized into three components, Life Science, Earth and Space Science, and Physical Science, each with a list of from seventeen to twenty-one learning opportunities. The **Junior Division Science OAIP** is also organized into these three components. To facilitate use of the pool, the learning opportunities in each component have been grouped into Science areas, using the order of the learning opportunities in *Science Is Happening Here*. For each learning opportunity, a number of objectives have been developed, with individual instruments being based on these objectives.

The **Junior Division Science OAIP** consists of two parts: the **Assessment Planning Guide** and a book of indexes to facilitate use of the pool, and a set of **Assessment Instruments Books**. The **Assessment Planning Guide** provides about thirty pages of information on how to use the assessment instruments, as well as a series of appendices which, like the indexes, are tools to assist in locating appropriate instruments for any given purpose and also in making the fullest use of the instruments.

A wide variety of instrument types is included in the pool. Nearly 40 per cent of the instruments are activity-based items, but there are also multiple choice, short answer, essay, and research items, as well as many calling for the interpretation/completion/creation of a table/graph/drawing. Each instrument is designed to provide experience in or to assess the development of some aspect of the knowledge, skills, and/or attitudes inferred in the specific learning opportunity.

The pool also encourages the use of several assessment techniques, a major technique being observation. Student self- and peer assessment are recommended. Teachers are encouraged to make careful and continuous observations of learning growth in different settings and situations, over time. Lists of indicators of achievement in all the skills and attitudes listed in *Science Is Happening Here* are provided, along with indicators for some additional processes used in Science. Sample student observation sheets are provided to record observations.

There are also some brief notes on safety considerations, metric notation, and sensitive issues which may relate to classroom activities.

Junior Division Science OAIP

ASSESSMENT PLANNING GUIDE

Science Education in the Junior Division

Science Is Happening Here: A Policy Statement for Science in the Primary and Junior Divisions 1988 outlines Ministry of Education policy for the expectations and development of the Science component of the curriculum in Ontario schools. The underlying philosophy of this document is an experiential, activity-based approach to learning where children "seek to discover and explain patterns and relationships in what they observe" (*Science Is Happening Here,* page 7). Classroom programs should present a balance of experiences in the three Science components outlined in *Science Is Happening Here* —Life Science, Earth and Space Science, and Physical Science—with attention and consideration being given to the needs, abilities, and safety of all children.

In a learning environment that provides opportunities for direct observation and hands-on experiences, children participate in whole-class, small-group, and individual activities which are designed to encourage the development of a range of attitudes, skills, and knowledge. Science activities also help students gain experience in planning, organizing, decision-making, and problem-solving.

Through the use of direct observation and the manipulation of materials and equipment, students are provided with opportunities to develop and use many skills. Language skills are reinforced through questioning, describing, explaining, writing, and the presenting of experiences. Each child's development of the skills of scientific enquiry is unique. The acquisition of Science knowledge through the development and use of skills allows each child to build concepts. The areas of knowledge appropriate for Science in the Junior Division are reflected in learning opportunities listed in *Science Is Happening Here* (pages 21 to 31). An activity-based, child-centred Science program also provides many opportunities for the development of attitudes.

The products, performances, and understandings that result from Science activities allow for the assessment and evaluation of each learner's growth in skills, attitudes, and knowledge as well as the evaluation of the effectiveness of the Science program.

This OAIP has been developed to assist educators in planning assessment and evaluation strategies for students in Junior Division Science programs. It is not only a compendium of instruments for the assessment of student learning in the Junior Division, but also a means of enriching Science programs by complementing and supporting the development of Junior Division Science curricula in general.

Planning Science Programs

Planning for the assessment and evaluation of learning in any program should be undertaken concurrently with program planning. *Science Is Happening Here* outlines provincial policy concerning program planning and the place of assessment and evaluation in Junior Division Science education (page 35). School boards may produce Science curriculum materials to reflect provincial policy and to support school and classroom-level planning.

School boards and teachers must plan their Science programs keeping both the provincial policy and the needs of individual students in mind. When making decisions about Science programs, several areas should be considered:

1. the philosophy and direction of provincial policy,
2. the needs and interests of the students,
3. the appropriate learning opportunities based upon the abilities of the students,
4. the planning of classroom activities with the students,
5. the unique balance of skills, attitudes, and knowledge necessary to meet the needs of the students,
6. the best combination of whole-class, group, and individual instruction for the program,
7. an appropriate balance among Life, Earth and Space, and Physical Sciences, and
8. the length of time to be devoted to each study area.

When developing the Science program and its student assessment and evaluation components, several **principles of Science learning** in the Junior Division should be considered. These principles of Science learning represent Ontario Ministry of Education policy for Science education for the Junior Division. The types of assessment and evaluation strategies and the instruments selected must flow from these principles and their underlying philosophy. In ensuring this, teachers and school boards will develop assessment and evaluation approaches and practices that are a natural and integral part of both the Junior Division Science curriculum and the way children in the Junior Division learn Science.

These foundation principles include:

1. a child-centred program,
2. direct involvement in hands-on explorations and investigations,
3. enquiry learning,
4. opportunities to develop curiosity about the world and self-confidence to explore it,
5. opportunities to manipulate, invent, build, test, and rebuild things,
6. an atmosphere that encourages questioning,

7. an atmosphere that emphasizes success,
8. development of interest and appreciation of the environment,
9. a basis for future learning, and
10. early and on-going identification, assessment, and documentation of student learning.

During the planning and development of Science learning programs, school boards, schools, and teachers must also give consideration to:

1. language across the curriculum,
2. multiculturalism,
3. safety,
4. partners in action,
5. computers in education,
6. sex equity,
7. care of animals,
8. outdoor education,
9. community involvement, and
10. meaningful applications to life.

Ministry of Education Policy/Program Memorandum No. 91 and *Science Is Happening Here* both emphasize the importance of the computer in education today.

> All students in Ontario schools shall have the opportunity, to the full extent of their abilities, to become knowledgeable and creative in their use of computers as personal tools. Educators developing curriculum for children in the Primary and Junior Divisions shall therefore include computer applications, where appropriate, in the areas of study defined in *The Formative Years . . .*
>
> Ontario's curriculum policy reflects the need for flexibility and autonomy in learning. Computers can be used to support this policy; teachers are expected to keep its implications in mind when choosing and designing computer activities for their students.
>
> *Ministry of Education Policy/Program Memorandum No. 91*

> Computers are a recent addition to the learning environment. They are useful in providing extensions of and support for science learning. They also help overcome restrictions of cost, time, accessibility, and safety through simulations of expensive, time-consuming, and dangerous activities. Computers should not, however, be regarded as a primary means of delivering science education or as a replacement for the direct investigation of natural and physical phenomena.

It is valuable for children to become knowledgeable and creative in their use of computers to:

- record, store, manage, analyse, share, and retrieve raw data;
- report results of investigations and experiments using words, numbers, or graphic representations;
- extend their thinking skills and creative abilities;
- communicate with peers over distance;
- accommodate special intellectual and physical requirements.

Children learn about technology by exploring and investigating simple materials and devices that are part of their everyday environment (e.g., adhesives, erasers, pencils, toys, pencil sharpeners). In addition, the use of more complex technologies such as computers gives children some awareness of the role of technology in society.

Science Is Happening Here (pages 12–13)

This **Assessment Planning Guide** has been written to support Science program planning as well as to outline ways in which this pool can be used to develop the student assessment and evaluation components of the program. The organization of the Junior Science pool permits several ways to identify appropriate instruments. A comprehensive cross-referencing system in Appendix A of this book and the indexes for the series help teachers identify and locate the instruments they need.

A significant feature of the **Junior Division Science OAIP** is its availability in electronic form. This allows efficient and easy access to all the indexing power of the database. Another feature of this pool is the large number of drawings and graphics. It is hoped that teachers will find the artwork useful for the preparation of displays, student work, and learning centres, as well as for the preparation of assessment devices for their Science programs.

Assessment and Evaluation

Assessment and evaluation practices are an integral part of all aspects of a program. Assessment strategies should be considered a natural component of curriculum planning. When students are involved in curriculum planning, they increase personal commitment to, and involvement in, the program itself. In this way, assessment strategies address student achievement, program effectiveness, and student commitment to learning. Assessment strategies planned in this way will address both curriculum objectives and student needs and interests. Assessment approaches and learning strategies will be mutually complementary.

Assessment strategies co-operatively developed as part of curriculum will:

1. support curriculum goals, aims, and objectives,
2. reflect student needs and interests,

3. complement planned teaching/learning strategies,
4. foster effective ongoing observations of student learning,
5. encourage frequent opportunities for recording observations in meaningful and practical ways,
6. generate meaningful data for the ongoing recording and tracking of student learning,
7. ensure that everyone involved in evaluation is appropriately informed about both the processes and the evaluative judgments made,
8. foster a successful, positive, and growth-oriented learning environment, and
9. provide appropriate information for making evaluative judgments about both students and program.

Science Is Happening Here promotes a hands-on, activity-based, child-centred program for learners in the Junior Division. It gives direction to school boards, schools, and teachers regarding the planning of appropriate Science programs while considering Ministry policy and local needs.

Planning Science programs for the Junior Division requires close attention to skill, attitude, and knowledge development. The effective development of skills, attitudes, and concepts occurs when learners are encouraged to ask questions, investigate situations, and solve problems that are of personal interest to them. By involving learners in activities that interest them, in an environment conducive to risk-taking, teachers are able to assess meaningful learning growth in all Science areas.

When planning is carried out co-operatively with students and as an integral part of program planning, assessment will occur naturally each time the teacher observes students while they are involved in a Science investigation. Teachers are able to make astute observations while interacting with the students during learning. Teachers develop their student-observation skills as they work with students to facilitate their learning. In this way, assessment data is generated from day-to-day teaching/learning situations.

It is important that assessment data be gathered in a wide variety of ways and from a broad base of Science experiences. Techniques may include strategies such as self- and peer evaluation techniques, student observation sheets (anecdotal, checklists, etc.), informal inventories and surveys, question and answer inventories, diagnostic inventories, student-made products and projects, student work folders, student work records, audiovisual recordings, and a variety of conferencing approaches (student, teacher, parent, etc.). Using various recording methods, teachers can make careful and continuous observations of learning growth in various settings and different situations, over time.

By recording assessment information, teachers are able to build up a cumulative record of each student's growth. Assessment information should be shared with other teachers, as appropriate, in order to make them aware of each student's growth. In this way, assessment

is used to build on the strength of the students, as well as to reflect on and revise the Science program and to make it more sensitive to the needs of learners. This collaborative approach also ensures continuity of program from the Early Years, through the Formative Years, and into the Transition Years.

Although the preceding information has focussed upon the gathering, recording, and analysis of data about a learner's progress or a program's effectiveness, evaluation, or the making of judgments based on that data, is equally important. This pool has been designed to assist teachers in planning and designing assessment strategies, and in making evaluative judgments regarding the learning growth of students based on the assessment data gathered.

To illustrate the relationship between assessment and evaluation, one could think about the process of obtaining a motor vehicle driver's licence. Obtaining a driver's licence in Ontario involves the assessment of a person's attitudes, skills, and knowledge about vehicles, safety, driving habits, and the rules, laws, and regulations for driving. Initially, the Ministry of Transportation gathers information about each applicant for a driver's licence (age, physical condition, eyesight, residence, and insurance) through the use of questionnaires and tests. The gathering and analysis of this information is called **assessment**. When the prospective driver has been issued a temporary permit, a judgment has been made about the driver's potential. This judgment is made on the basis of the initial assessment data. This step is called **evaluation**.

The driver-in-training (learner) now undergoes instruction by actually driving a car on public roads. At this stage, most of the time is spent practising the skills of driving and learning the rules of the road. The instructor is continually **assessing** the performance of the learner, while making periodic judgments about the worth of the performance (**evaluating**). Advice is frequently offered to correct poor and unsafe actions. Through the continual use of instruction, assessment, evaluation, and remediation, student drivers are brought to a level of performance where both the instructor and the student believe that it's time to take the final tests for a permanent licence. By using a multiple-choice test (assessment of knowledge) and observational checklists and rating scales while the student is driving the automobile (assessment of skills), enough information is gathered to judge whether the student's knowledge, skills, and attitudes meet the standards required for a permanent licence.

Once successfully on their own, drivers continue to practise their skills and review the rules and regulations concerning driving, in order to maintain the ability and understanding they have developed.

Teaching and learning Science offer many similar situations. Students are given opportunities to learn and develop skills and attitudes and to acquire knowledge of Science through their involvement in an enquiry-based Science program. The role of the teacher in this environment is similar to that of both a composer and the conductor of the composer's music. As a composer creates a musical score and lyrics, the teacher creates the Science program, establishing the conceptual framework in which specific skills and attitudes are to be developed. Once the program is designed and under way, the teacher assumes the role of

encouragement and directions when required, and making small adjustments to the program for both individuals and groups of students. This will occur only if assessment strategies are planned in advance of learning and involve the ongoing processes of diagnostic, formative, and summative evaluation.

Since learning is continuous, teachers must select various episodes along the journey of Science learning to gather information, to make judgments, and to remediate, refocus, or maintain the planned activities. The regular use of feedback from a variety of assessment approaches allows the program to build on the strengths of the learners and to ensure continuous growth and development in the requisite skills and attitudes.

Once teachers have planned their programs and established their objectives, selecting assessment instruments and preparing student observation sheets from the **Junior Division Science OAIP** is an easy task. This pool provides teachers with sample student observation sheets, progress indicators for the assessment of skills, attitudes, and other learning areas, assessment instruments that can be used in program and assessment planning, and general information to support assessment and evaluation in diagnostic, formative, and summative modes.

Diagnostic assessment is usually undertaken at the **beginning** of a teaching plan (for a concept, a unit, a term, or a school year). It helps determine the current status of a particular student or group of students in relation to a part of the curriculum, in order to decide how much review is necessary, how to approach a new concept or skill, or what resources to use. On the basis of this evaluation, the teacher can prepare a series of Science lessons, demonstrations, or activities to meet the needs of the learners.

Formative assessment is the ongoing gathering and analysis of information about situations and reactions and responses of learners during the teaching/learning process. Evaluation based on this information allows the teacher to take corrective measures that reinforce the learning of attitudes, concepts, and skills so that students are prepared for subsequent learning. It also gives the teacher a picture of each individual student's learning growth.

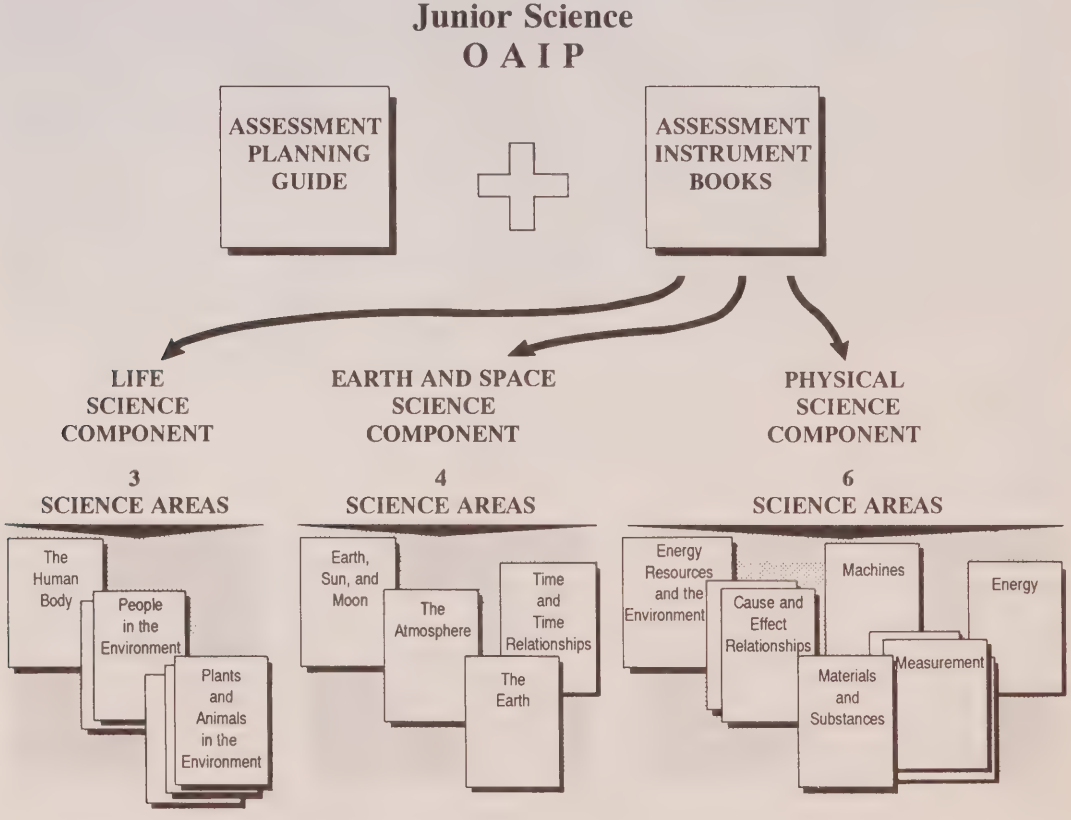
Summative assessment occurs at the end of a learning sequence, unit, or theme. It enables the teacher to evaluate each student's learning growth, and also to plan appropriate future learning activities.

Effective assessment and evaluation strategies support learning by informing the teacher, the student, and the parent about the student's learning strengths and needs. Programs are then planned to build on the strengths and satisfy the needs. The long-term chronicling of ongoing observation creates a base of valuable information. In elementary schools, the primary assessment strategy should be observation. Paper-and-pencil testing results should be used mainly for program planning. The use of assessment folios, containing a range of observation records, test results, student comments, and teacher anecdotal records allows for more effective evaluation and authentic reporting to the parents and the learner.

Using the Junior Division Science OAIP

Organization of the Junior Division Science Pool

The **Junior Division Science OAIP** is composed of two basic parts: the **Assessment Planning Guide** (this document) and **Assessment Instrument Books**. There is also a book of indexes which help to locate instruments. The instruments are grouped into the three major Science components used in *Science Is Happening Here:* Life Science, Earth and Space Science, and Physical Science. Within each of these Science components, the assessment instruments are organized in **books**, titled according to the Science areas listed on page 11. This organization is diagrammed below.



SCIENCE AREAS

	Learning Opportunities
LIFE SCIENCE	
Plants and Animals in the Environment	L01-L11
People in the Environment	L12-L14
The Human Body	L15-L18
EARTH AND SPACE SCIENCE	
The Earth	E01-E03
The Atmosphere	E04-E08
Time and Time Relationships	E09-E17
Earth, Sun, and Moon	E18-E21
PHYSICAL SCIENCE	
Materials and Substances	P01-P03
Measurement	P04-P05
Cause and Effect Relationships	P06-P08
Machines	P09-P10
Energy	P11-P14
Energy Resources and the Environment	P15-P17

This **Assessment Planning Guide** is intended to act as a gateway to the resources in its appendices and in the books of instruments. It outlines principles and practices for good assessment and evaluation, shows teachers how to plan for learning in Science through the use of a variety of resources, and gives detailed descriptions of the skills and attitudes found on page 20 of *Science Is Happening Here* through the indicator lists found in Appendices B (pages 57 to 73) and C (pages 74 to 86). A third series of indicator lists is provided in Appendix D (pages 87 to 94). These cover processes used to promote learning and to develop Science skills and attitudes. The **Assessment Planning Guide** also cross-references the learning opportunities from *Science Is Happening Here* with the objectives of the instruments in the pool (see Appendix A, pages 33 to 56). This cross-referencing index forms the basis for the organization of the instruments.

The assessment instrument books contain a rich collection of instruments to accommodate the wide variety of Science programs and the broad range of learners in the Junior Division. Each instrument contains a complete description of a Science activity that can be adapted by the teacher during the planning of a Science program, along with information for the assessment and evaluation of student achievement in Science. The book of indexes will provide assistance in locating instruments to satisfy specific needs.

FIELDS OF INFORMATION IN THE INSTRUMENTS

CODING FIELDS

DISCIPLINE
DIVISION
COMPONENT
SCIENCE AREA
LEARNING OPPORTUNITY CODE
OBJECTIVE CODE
INSTRUMENT CODE
ITEM TYPE
DIFFICULTY LEVEL

CLASSIFICATION FIELDS

KEYWORDS
LEARNING DOMAINS
Skills Attitudes Knowledge
LEARNING OPPORTUNITY
OBJECTIVE

ITEM FIELDS

ITEM
MATERIALS AND EQUIPMENT
ASSESSMENT
- Skills
- Attitudes
- Knowledge
- Other

PLANNING FIELD

TEACHER NOTES

Fields of Information in an Instrument

Each instrument in the pool, regardless of where it is found, is composed of the same fields of information organized into four major groups:

1. Coding fields
2. Classification fields
3. Item fields
4. Planning field

Each of the four groups identifies and describes certain features of the instrument. For example, in the group called **Coding Fields** there is a field called **Item Type** which categorizes the instrument according to its format and assessment approach; the list of instrument types used is on page 15. The field called **Instrument Code** gives the instrument its own unique code, different from that of any other instrument in the complete collection of OAIP/BIMO materials.

The illustration on page 12 indicates the four groups of fields and lists the names of all the fields found in each of the four groups. Although the information in the fields is different for each instrument, the function of the information in each field is the same throughout the pool. The purpose of these fields is to help teachers select the instruments they need.

The Coding Fields

DISCIPLINE: Science	**INSTRUMENT CODE:** SNCJU E P000
DIVISION: Junior	**ITEM TYPE:** activity
COMPONENT: Physical Science	**DIFFICULTY LEVEL:** medium
SCIENCE AREA: Materials and Substances	
LEARNING OPPORTUNITY CODE: P02	
OBJECTIVE CODE: PHYS 106	

The purpose of the **coding** fields is to provide information, often in **coded form**, that helps **identify** each instrument.

The fields in the left-hand column provide information **locating** the instrument within the entire OAIP/BIMO collection of materials. The fields in the right-hand column (except the instrument code) **describe** the instrument. Each field has a range of alternatives which will assist in selecting instruments suited for a particular purpose.

The following are descriptions of the fields:

Discipline and Division

The first two fields in the left-hand column indicate that this pool was designed for the subject of **Science** in the **Junior** Division. They are used to locate this particular pool of instruments in a large database of OAIP/BIMO subject pools.

Component

This field refers to the way in which the learning opportunities are organized in *Science Is Happening Here.* All the instruments in the pool are grouped according to the three components established in *Science Is Happening Here:* **Life Science**, **Earth and Space Science**, and **Physical Science**.

Science Area

The instruments within each component are further organized within Science areas (listed on page 11).

Learning Opportunity Code

Each of the learning opportunities found in *Science Is Happening Here* has been assigned a number for easy reference (Appendix A, pages 33-56). This code is composed of a single letter and a two-digit number. The letters L, E, and P signify learning opportunities in the Life Science, Earth and Space Science, and Physical Science components respectively.

Objective Code

This field identifies the objective for which the item is designed. Each Science area has at least two objectives. The objective code has two parts. The first is a four-letter code which represents one of the three main Science components in *Science Is Happening Here,*

LIFE = Life Science ERSP = Earth and Space Science PHYS = Physical Science

The second part is a three-digit number which positions the objective in a sequence within its Science area. These objectives are listed in Appendix A.

Instrument Code

Every instrument in the OAIP/BIMO subject pools is assigned a unique number. This ensures finding the desired instrument when searching a large computer database across several subject pools. This unique code, for Junior Science, begins with SNCJU (Science Junior). This is followed by two spaces, the letter E (English), and another space. Next is a letter (L, E, or P) denoting the Science component, and finally there are three digits. These digits are consecutive numbers within the component, each of the three series starting with 001. A sample number would be SNCJU E L001.

Item Type

The range of types of items is shown in the list below. Descriptions of some types of instruments are provided in the Introduction, pages xiii to xiv.

Activity
Alternate response
Matching
Multiple choice
Multiple selection
Completion
Essay
Experiment design
Extended response
Interpreting/Completing/Creating a diagram
Interpreting/Completing/Creating a graph
Interpreting/Completing/Creating a table
Short answer

Difficulty Level

The codes in this field (low, medium, high) **do not relate to grade levels**. Furthermore, they **should not be construed as standards**. They are intended to be used as a **guide** in the selection of items to meet the needs of the individual classroom Science program and to reflect the experiences of the students. **Low difficulty level** items generally require some **recall** of basic facts and a **minimum** of complex thinking skills. Any manipulation of materials and equipment required in these items is well within the psychomotor skills of students in the Junior Division. **Medium difficulty level** items will require more **advanced knowledge** of the concepts stated in the objective, the use of **advanced thinking skills**, and/or better facility in the manipulation of equipment and materials. **High difficulty level** items often require **more complex, higher order thinking skills**, a **more detailed knowledge** of the Science concepts, a higher level of planning skill, and/or better psychomotor skills.

The Classification Fields

KEYWORDS: sink float buoyancy hydrometer density

LEARNING DOMAINS

Skills	Attitudes	Knowledge
predicting	accuracy	matter
observing	curiosity	
hypothesizing	risk taking	

LEARNING OPPORTUNITY

Children shall have opportunities to investigate the physical properties of one or more materials.

OBJECTIVE

The learner will investigate how an object floats in different liquids (e.g., water, milk, vinegar, soda water, shampoo, glycerine, salt water).

The classification fields indicate the correlation of the individual item with the attitudes, skills, and knowledge listed in *Science Is Happening Here* (page 20). Through the use of this group of fields, teachers will be able to identify and select items which are related to their classroom Science programs.

Keywords

The keywords represent important concepts, ideas, or content in an item not referred to in another indexed field. The keywords provide the most detailed means of accessing items. Generally, there are no more than three keywords listed for any instrument. The keywords were selected as words judged to be in common use in the planning of Science programs.

Learning Domains

The learning domains identified in *Science Is Happening Here* are Knowledge, Skills, and Attitudes. The specific aspects selected for each domain are found on page 20 of *Science Is Happening Here*. The skills and attitudes are also found in Appendices B (pages 57 to 73) and C (pages 74 to 86) of this **Assessment Planning Guide**, with lists of related indicators. Since students use a combination of knowledge, skills, and attitudes when learning Science, the specific skills, attitudes, and knowledge concepts assigned to any instrument should not be considered as absolute.

The Learning Domains field on page 16 shows that the skills of **predicting**, **observing**, and **hypothesizing** are likely to be used by students undertaking this activity. This also indicates which Science Skills Indicator lists (see Appendix B, pages 57 to 73) are appropriate for use with this item. The attitudes list in the example signifies that the activities in this instrument will provide students with opportunities to use their **curiosity**, to be involved in **risk taking** when solving problems, and to demonstrate **accuracy** when observing results of an activity. Lists of the indicators for the attitudes are found in Appendix C (pages 74 to 86). The relevent knowledge concept is **matter**.

Learning Opportunities

Ministry policy regarding Science instruction in the Junior Division is outlined in *Science Is Happening Here*. Pages 22 to 31 of this policy document describe many "learning opportunities" which children should have in the Formative Years of their schooling. Each instrument in the pool is classified under the most relevant learning opportunity, and this learning opportunity is quoted as it appears in *Science Is Happening Here* (pages 22 to 31). The Junior Science learning opportunities and their code numbers are found in Appendix A (pages 33 to 56). Each instrument is designed to assess some aspect of the knowledge, skills, and attitudes inferred by the specific learning opportunity listed in this field.

Objective

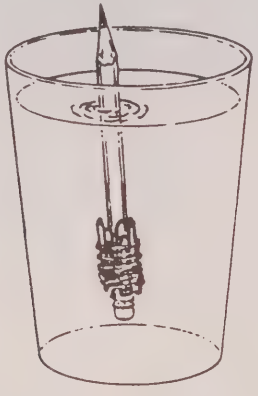
The objectives are also found in Appendix A (pages 33 to 56). They were written specifically for the **Junior Science OAIP** to support the learning opportunities in *Science Is Happening Here*. The objectives provide more detailed information than the learning opportunities and relate more specifically to the Science activities experienced by the students.

An item may deal with specific parts or all of its objective. In the case of the objective in our example, some items focus on **constructing** open and closed circuits, whereas others deal exclusively with **comparing** open and closed circuits. Some items cover a combination of constructing **and** comparing open and closed circuits.

ITEM

1. Use an elastic band to attach several paper clips to the end of a pencil so that it will float upright in a glass of water. Use this as a liquid tester.

2. Observe how high the tester floats in a variety of liquids. Make sure the same amount of liquid is used for each test.



3. Predict in which liquid the pencil will float:
   (a) the highest. _____
   (b) the lowest. _____
   (c) the same as in the water. _____

4. In which liquid did the pencil float:
   (a) the highest? _____
   (b) the lowest? _____
   (c) the same as in the water? _____

5. Why do you think there is a difference?

MATERIALS AND EQUIPMENT

- pencil
- paper clips
- elastic band
- water
- cooking oil, vinegar, corn syrup, kool aid
- salt water
- tall, clear containers the same size

ASSESSMENT

Skills

Refer to the list of Indicators for

Predicting . . . . . p. 67
Observing . . . . . p. 61
Hypothesizing . . . . . p. 68

Attitudes

Refer to the list of Indicators for

Accuracy . . . . . p. 81
Curiosity . . . . . p. 85
Risk Taking . . . . . p. 86

Knowledge

4. The pencil should float the highest in corn syrup and the lowest in water or kool-aid.

5. Any reasoned response is acceptable.

Additional Ideas

Refer to the list of Indicators for

Investigating from Primary Sources . . . . . p. 90

The item fields consist of the item itself, the list of materials and equipment required for an activity item, and the assessment criteria to be used with the item.

Item

The item is enclosed by two dotted lines. The item can be very short, or extended over two or three pages where activities and diagrams are involved. In many items, lined areas, boxes, and tables have been included for student responses. For easier reading by young children, the items have been printed in a larger type size, except in some of the tables. Teachers should modify items to make them congruent with the Science experiences in their classrooms.

Materials and Equipment

Virtually every activity-based item requires the advance procurement of specific materials and/or pieces of equipment. Most of these are readily available as standard supply items in the school, or easily and inexpensively purchased in local grocery or hardware stores. Some items require the use of plants grown from seeds (see Appendix F, pages 132 to 134) or special observations of properly housed and cared for animals (see Appendix H, page 137). The quantities required for one student or a single set-up are indicated. In many cases, materials and equipment can be shared by groups of students, but care should be taken to ensure that there are enough supplies for the whole class to participate.

Assessment

This field gives a range of suggestions for assessment. The first part refers teachers to the pages in this **Assessment Planning Guide** where appropriate **skills indicators** and **attitudes indicators** for the item can be found. Next, the specific **knowledge answer** is provided and, if necessary, other possible **knowledge responses** for the item are also

listed. Additional assessment ideas or reference to additional indicator lists for consideration by teachers may be found in the subsection labelled "Additional Ideas."

The Planning Field

TEACHER NOTES

1. Liquids have different densities. The greater the density of the liquid the higher the pencil will float.

2. Salt water, cooking oil, corn syrup, and kool-aid are good liquids to test.

3. Make up jam jar containers with concentrated salt and water solution, cooking oil, and milk. Be sure the jars are tall enough for the pencil tester.

4. A tack could be placed in the pencil eraser.

This field provides teachers with additional information valuable in planning for the use of the activities in the pool. All of this additional planning information is found under the heading "Teacher Notes."

This field may contain useful background information on the Science content or technology relevant to the item; important strategies for using the item; suggestions for extended study; and resource references.

Because so much of this Junior Science pool is activity-based, safety considerations are of particular importance. In most cases, safety requirements are automatically suggested by common sense and good judgment. It is expected that teachers will follow school board and school policies at all times. In those items that require materials to be heated, safety is of special concern. In some cases, where special procedural information or handling directions should be demonstrated or reviewed with learners prior to conducting investigations to ensure safety during the activity, such safety procedures or concerns are included.

Other information and interesting ideas relevant to the item may be included here.

Locating Instruments in the Pool

The **Junior Division Science OAIP** is available in two formats: as a series of printed books and on a compact disc used with specified computers. Locating instruments in the paper version is dealt with first here. The process for searching with the computer system on the compact disc is outlined on page 26.

The terms *component*, *Science area*, *learning opportunity*, and *objective* as used in the **Junior Science OAIP** are explained on pages 14 and 17. These concepts are used to organize the instruments in the print version.

The first level of grouping is by component: **Life Science**, **Earth and Space Science**, and **Physical Science**. The covers of the instrument books are colour-coded according to the Science component for easy identification. **Life Science** books have green covers; **Earth and Space Science** covers are Blue; and **Physical Science** covers are red. Within each component, the instruments are organized by Science area. Each book contains instruments for only **one** Science area, but some Science areas are so extensive that they have been bound in more than one book. Within each Science area, the instruments are organized by the sequentially numbered objectives, and within each objective an attempt has been made to order the instruments as they might be used in presenting and assessing a particular concept or topic. Another principle followed is that, if the components are put in the order followed in *Science Is Happening Here*, and the Science areas as on page 11 of this book, the learning opportunities will be in the same order as in *Science Is Happening Here*.

On the basis of this organization, there are several ways in which appropriate instruments can be found in this pool. The four pathways outlined below involve using both this **Assessment Planning Guide** and the **Assessment Instrument Books**. These pathways are:

1. Learning Opportunities
2. Science Areas
3. Objectives
4. Keywords and Index

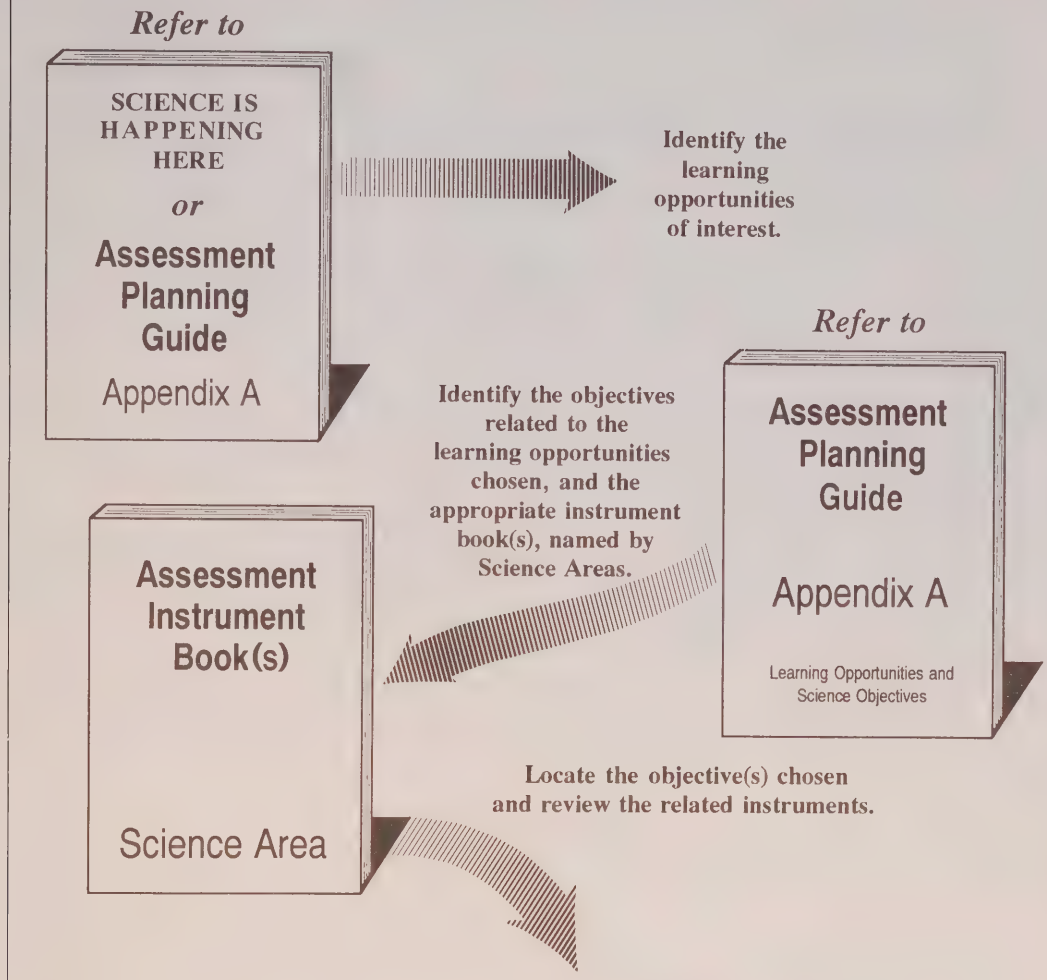
Familiarity with the pool and its organization will enable users to develop their own unique pathways to the assessment instruments and related resources within it.

Learning Opportunities Pathway

Items in this pool can be accessed by starting with the learning opportunities from *Science Is Happening Here*. These have code numbers based on the order in which they appear in *Science Is Happening Here* (pages 22 to 31). The complete list of learning opportunities and their code numbers is found in Appendix A. The diagram on page 23 outlines the major steps for using learning opportunities to access the pool, also described on page 24.

FINDING INSTRUMENTS BY

LEARNING OPPORTUNITIES


Refer to
SCIENCE IS HAPPENING HERE
or
Assessment Planning Guide
Appendix A
Identify the learning opportunities of interest.
Refer to
Assessment Planning Guide
Appendix A
Learning Opportunities and Science Objectives
Identify the objectives related to the learning opportunities chosen, and the appropriate instrument book(s), named by Science Areas.
Assessment Instrument Book(s)
Science Area
Locate the objective(s) chosen and review the related instruments.

Select assessment instruments for...

A SCIENCE THEME

1. Refer to *Science Is Happening Here* and select the learning opportunities for which assessment instruments or resources are needed. The learning opportunities can also be found in Appendix A of this book, where they are given codes for quick reference.

2. Next, using Appendix A, locate the learning opportunity(ies) chosen and review the related objectives. Use the objective code numbers to list relevant objectives, and determine which assessment instrument book(s) should have suitable instruments.

3. Locate the selected objective(s) in the book(s) and choose appropriate items from the instruments located there.

Science Areas Pathway

The diagram on page 25 shows how to find a suitable selection of instruments for a Science theme about weather, starting with the appropriate Science area. The challenge in using this pathway is to find the best match between your theme and one or more of the relevant Science areas in this pool.

1. Refer to page 11 of the **Assessment Planning Guide** for the list of the Science areas used in the pool. The Science area most relevant to **weather** is **The Atmosphere** in the **Earth and Space Science** component.

2. In Appendix A of this **Assessment Planning Guide** (pages 33 to 56), peruse the objectives for the Science area selected. (This step can be skipped, but it usually saves time by narrowing the search for appropriate instruments.)

3. Next, go to the instrument books titled **The Atmosphere**.

4. Browse through these instrument books to find suitable items. The instruments are grouped by objectives, with several instruments available for each objective.

Objectives Pathway

The diagram on page 27 illustrates how to use objectives to locate instruments appropriate for a particular lesson.

1. Refer to Appendix A, Learning Opportunities and Science Objectives, in this **Assessment Planning Guide**. If the component and most likely Science area are known, the search can be immediately narrowed to the relevant lists of objectives. Identify and record both the related Science area(s) and the appropriate objective codes.

2. Locate the instrument book(s) for the objectives you have noted.

3. Browse through the books to find the instruments for the objectives you have previously noted. The instruments are organized sequentially by their objective code numbers, making it easy to find the instruments for a particular objective.

4. Select assessment instruments based on their suitability for the students.

FINDING INSTRUMENTS BY

SCIENCE AREAS

Refer to

Assessment Planning Guide

PAGE 11

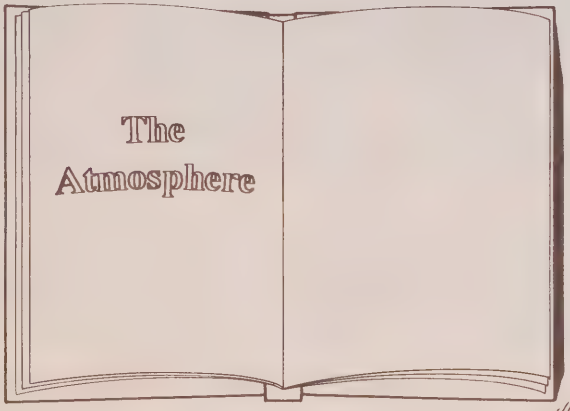
Select the Science Area of interest
(e.g., The Atmosphere)

Then refer to

Assessment Planning Guide

Appendix A

Then refer to the instrument book(s) for the Science Area chosen and select appropriate objectives.



Browse through the book(s) to find

assessment instruments for the specific theme... (e.g.)

WEATHER

Keyword and Index Pathway

The pool can be accessed using keywords. This approach is diagrammed on page 28. The keywords are included in the book of indexes.

1. Make a list of keywords appropriate for a Science theme or unit of study.
2. Look up the keywords in the index book and record the book title(s) and page numbers of the instruments relevant to the theme. Further keywords may be found by scanning the index.
3. In the appropriate instrument book(s), locate the relevant instruments, using the page numbers on the list of index terms created. Make a selection of suitable instruments.

The **Junior Division Science OAIP** is also available in an electronic format, on CD-ROM, with a computer system called FINDIT, available in both DOS and MAC versions. The following general instructions apply only to searching and printing. Installation instructions are provided with the compact disc.

1. The Junior Science database is only one of several OAIP databases available on the CD-ROM. Having got into the FINDIT system, highlight the JUNIOR SCIENCE option. Wait until the database has been loaded.
2. Many of the fields in the database are searchable. The user can start with a component, a learning opportunity or learning opportunity code, an objective code, keywords, or any other searchable field. The list of searchable fields appears on the screen.
3. When a field has been chosen, a further list of options will appear. When an option is selected, a message at the top of the screen will indicate how many records in the database satisfy this chosen criterion.
4. To narrow the selection of instruments further, the user can select additional options, one by one, until the results have been reduced to a reasonable number of instruments for browsing. When the content has been narrowed as much as possible, other criteria such as difficulty level(s) and item type(s) can be used for searching.
5. When an appropriate selection of instruments has been made from those browsed, the items or the complete instruments can be printed out.
6. When a user has become familiar with the search system and with the database, a much quicker process can be used by combining criteria from several fields in a single search request.

More detailed searching and printing instructions are provided with the CD-ROM system.

FINDING INSTRUMENTS BY

OBJECTIVES

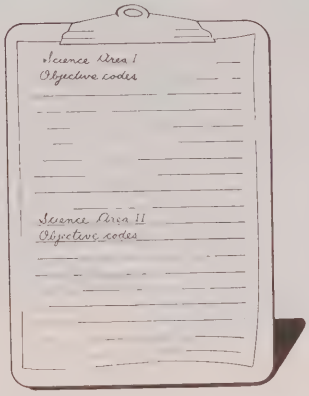
Refer to

Assessment Planning Guide

Appendix A

Learning Opportunities and Science Objectives

Identify and record the appropriate Science Area(s) and objective codes.



Go to

Assessment Instrument Book(s)

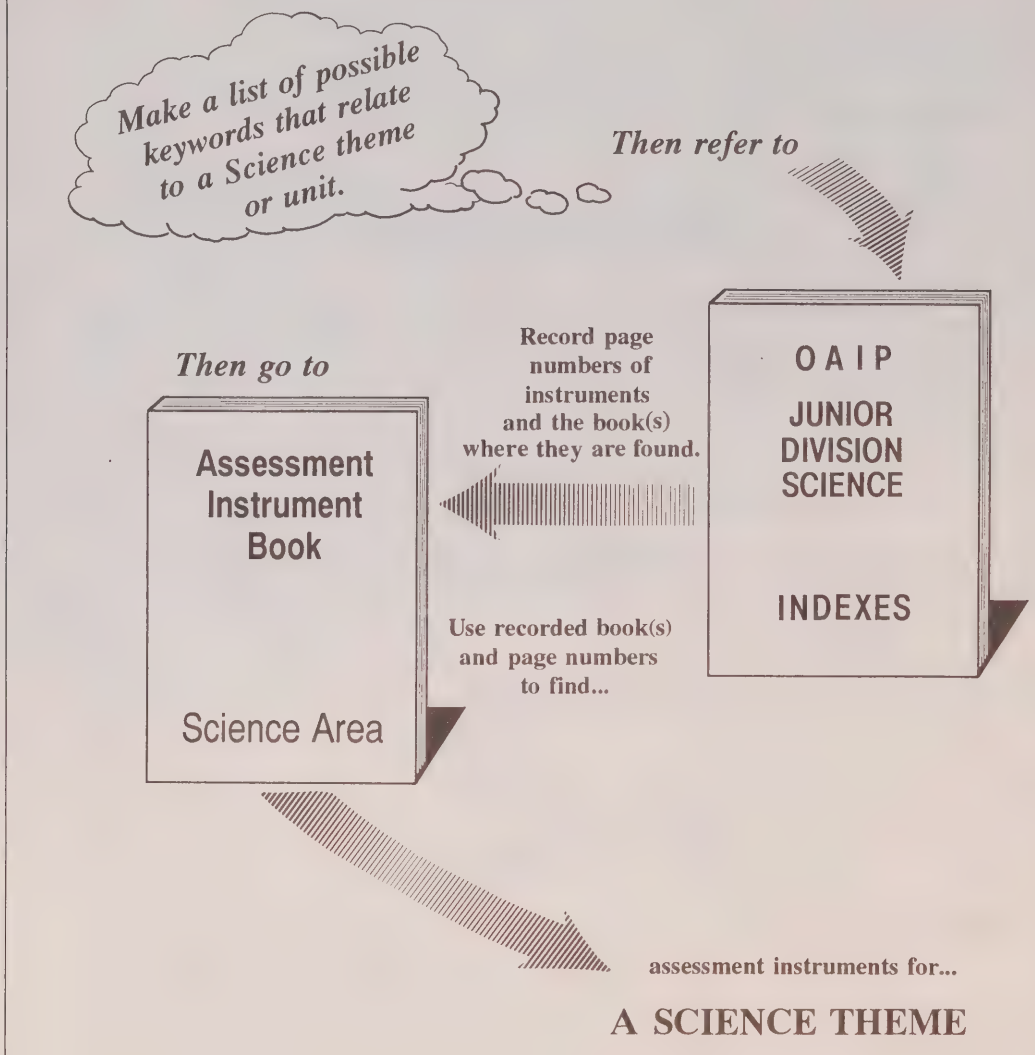
Locate the objectives and their instruments.

Select the appropriate assessment instruments for...

A UNIT OF STUDY

FINDING INSTRUMENTS BY

KEYWORDS


Make a list of possible keywords that relate to a Science theme or unit.
Then refer to
OAIP
JUNIOR DIVISION SCIENCE
INDEXES
Record page numbers of instruments and the book(s) where they are found.
Then go to
Assessment Instrument Book
Science Area
Use recorded book(s) and page numbers to find...
assessment instruments for...
A SCIENCE THEME

Using the Skills, Attitudes, and Other Indicator Listings

The indicators listed in Appendices B, C, and D expand and enhance the skills and attitudes outlined in *Science Is Happening Here*. The wide variety of indicators in this pool allows for the planning of child-centred, activity-based Science curricula and the appropriate monitoring of the effectiveness of those curricula. Care must be taken to choose indicators that are relevant to each classroom situation and each school board's Science curriculum, so that by the end of the Junior Division all skills, attitudes, and learning opportunities listed in *Science Is Happening Here* have been considered.

Within individual schools, the Junior Division teaching team can use the indicator lists to plan their Science themes and identify which skills, attitudes, products, and performances are most important to their school program. Communication among all teachers within the school is important. In this way, the growth and development of students can be monitored in a meaningful way. This co-ordination of board-wide and in-school planning results in better information for reporting progress to both students and parents. Planning of this nature also ensures program continuity through the Formative Years and into the Transition Years.

Appendix E contains three scenarios designed to demonstrate some of the different ways to develop lists of indicators and student observation sheets for observing and recording the accomplishments and development of learners in the Science program. Appendix E also includes sample observation sheets applicable to Science learning. By modifying these forms, teachers can begin to design appropriate student observation sheets for their own classrooms.

Several guidelines should be considered when using the indicator lists to prepare student observation sheets.

1. One cannot simultaneously monitor every skill, attitude, product, and performance in a Science learning situation. Teachers must select those indicators that are most important to their program at a particular time. It is better to monitor a few indicators over a period of time than attempt to observe a large number of indicators at one time.

2. Focus on one or two skills and/or attitudes at a time and plan the Science theme or unit around those specific skills. Planning should involve the students since they should be aware of the skills and attitudes involved in the study. Once the program is under way, the development of the specified skills is more readily monitored because the activities have been planned with the skills in mind. Since the students are aware of the kinds of skills they are using, the observations made of the students are relevant to both the teacher and the student.

3. The indicators can be used to prepare checklists, rating scales, and anecdotal record sheets, depending upon what is most suitable to the teacher's program and style of teaching. Care should be taken with the descriptors used on rating scales to avoid the use of terms which have a negative connotation for the learner.

4. In preparing student observation sheets, teachers must allow for documentation of student growth and development over time. The ongoing chronicling of student progress supports the philosophy of *Science Is Happening Here*. Each child develops and learns differently, and the observation of individuals in a variety of Science activities gives teachers a more accurate view of a child's development and accomplishments over time.

Using the Graphics and Drawings in the Pool

Many learners in the Junior Division use pictures to retain and express their learnings in Science. Often, students use drawings to demonstrate or indicate their accomplishments. When preparing assessment devices in Science, teachers should be sensitive to the needs of all students and make provision for the prudent use of drawings when necessary. The use of secondary sources, however, should never replace the hands-on emphasis of the Junior Division Science program.

This pool contains a large number of drawings, charts, and tables. Although the drawings are used for specific items, they could be applied to a wide range of learning situations. Teachers may copy and use the drawings to enhance the Science program in their classrooms.

The drawings could be used in a variety of ways, some of which are:

1. As overhead transparencies
2. On student-prepared posters
3. In student notebooks, folders, and projects
4. In designing bulletin board displays
5. In the preparation of learning centres
6. In illustrating the procedures for an experiment

School board curriculum planners and developers may also wish to use the drawings in the preparation of locally designed themes or units.

APPENDICES

Appendix A

LEARNING OPPORTUNITIES AND SCIENCE OBJECTIVES

This appendix lists all the objectives which have been developed for the **Junior Division Science OAIP**. These objectives relate to the learning opportunities in *Science Is Happening Here*. Although some objectives could relate to more than one learning opportunity, each has been listed here with the most relevant one. Each instrument in the pool is based on one of the objectives, and is therefore related to at least one of the learning opportunities in *Science Is Happening Here*. The code at the left of an objective in this listing is the objective code and is unique to that objective.

LIFE SCIENCE

PLANTS AND ANIMALS IN THE ENVIRONMENT

L01: Children shall have opportunities to demonstrate concern and care for the environment (e.g., by planning and conducting a schoolyard beautification project, assuming responsibility for the care of classroom plants or animals).

Note: This learning opportunity is also found in the Physical Science component (P15); however, the examples are different.

The learner will:

LIFE 01 investigate and identify the present condition of the local natural environment.

LIFE 02 explore different habitats in the local environment (woodlot, pond, field) and identify reasons for maintaining them in their natural state.

LIFE 03 describe the advantages and disadvantages of the methods used to control weeds (e.g., natural, physical, chemical).

L02: Children shall have opportunities to investigate ways to care for the environment.

The learner will:

LIFE 04 investigate how caring for the environment helps plants and animals to survive.

LIFE 05 investigate the advantages and disadvantages of technologies used to control animals.

LIFE 06 investigate ways in which technology aids in the conservation of animals and plants.

L03: Children shall have opportunities to observe, describe, and compare a wide variety of plants and animals common to the immediate environment.

The learner will:

LIFE 07 recognize major parts of plants and outline their functions.

LIFE 08 recognize and name common plants.

LIFE 09 describe the principal characteristics of hard-stemmed (woody) and soft-stemmed (herbaceous) local plants (e.g., trees and grasses) found in an outdoor area.

LIFE 10 describe similarities and differences among trees (e.g., leaves, barks, flowers, seeds, and other structures) and use keys to identify them.

LIFE 11 give reasons for plants being considered living things.

LIFE 12 identify the major external parts of a common animal and describe their functions.

LIFE 13 collect living creatures for observation and return them to their environment.

LIFE 14 identify and compare some of the distinctive characteristics of common groups of vertebrates.

LIFE 15 identify and compare some of the distinctive characteristics of common groups of invertebrates.

LIFE 16 observe and describe how a common animal breathes.

L04: Children shall have opportunities to use equipment to observe plants and animals.

The learner will:

LIFE 17 make and use a variety of equipment to aid in collecting animals for observation.

LIFE 18 observe a variety of common objects or materials using a hand lens, microscopes, and binoculars.

LIFE 19 use sketches and written descriptions to record what is observed through a magnifying device.

LIFE 20 identify one characteristic of an object or organism that can be seen better with a magnifying glass.

LIFE 21 estimate the circumferences and diameters of tree trunks, and use callipers and a measuring tape to check the estimates.

LIFE 22 estimate the heights of trees and check the estimates by comparing them with the known heights of other things.

L05: Children shall have opportunities to develop their own simple systems for classifying plants and animals.

The learner will:

LIFE 23 group plants from a study area according to observed similarities and differences.

LIFE 24 classify seeds based on observations.

LIFE 25 classify fruits based on observations.

LIFE 26 classify animals using a variety of observed characteristics.

LIFE 27 identify the difference between vertebrates and invertebrates.

LIFE 28 sort plants or animals studied into groups on the basis of two properties.

LIFE 29 classify local animals according to the food they eat.

L06: Children shall have opportunities to investigate the life cycles of some common plants and animals.

The learner will:

LIFE 30 identify and describe the functions of the major parts of flowering plants.

LIFE 31 investigate methods of plant reproduction (e.g., seeds, rhizomes, slips, bulbs, cuttings, spores, roots).

LIFE 32 investigate and compare methods of seed dispersal.

LIFE 33 determine older and younger trees among trees which have been cut down, using the annual rings.

LIFE 34 identify features of the annual rings of a tree and relate them to some of the conditions the tree has experienced.

LIFE 35 find ways of inferring the ages of common animals.

LIFE 36 arrange events such as growth and reproductive cycles into correct sequence.

LIFE 37 describe methods of tracking animals that migrate.

L07: Children shall have opportunities to use materials to replicate a natural environment.

The learner will:

LIFE 38 prepare a vivarium or aquarium that best corresponds to the natural environment of a small animal, and maintain and observe the animal in it.

LIFE 39 construct and test a variety of bird feeders.

L08: Children shall have opportunities to observe and describe plants and animals peculiar to a particular habitat.

The learner will:

LIFE 40 identify and describe some of the different types of habitats in which plants can live.

LIFE 41 examine and identify the types and forms of vegetation in a selected area (e.g., lawn, bush, fence row).

LIFE 42 locate, draw, and label local common plant species on a map of a study area.

LIFE 43 identify and describe some environmental conditions that affect plants.

LIFE 44 identify the adaptations which plants use to help them survive.

LIFE 45 recognize and identify local weeds and describe how they survive in the environment.

LIFE 46 identify and demonstrate an appropriate sampling technique for a natural community.

LIFE 47 identify a common animal and describe how it is suited to its habitat.

LIFE 48 observe and/or record evidence of animals living in or passing through a study area.

LIFE 49 make an inventory of the living creatures found in a study area and use the information to predict food chains.

L09: Children shall have opportunities to observe the ongoing process of change in a natural community.

The learner will:

LIFE 50 describe the influence of natural factors (e.g., water, wind, sunlight, soil) on living things.

LIFE 51 describe how plants and animals survive seasonal changes.

LIFE 52 describe how a habitat may change over time.

L10: Children shall have opportunities to design and perform an experiment involving seed germination or plant growth.

The learner will:

LIFE 53 observe the germination of different seeds and record the results.

LIFE 54 design and conduct experiments to determine the ideal conditions necessary for germination of seeds (emphasize variable depth).

LIFE 55 design and conduct experiments to compare the growth rates of different types of seedlings.

LIFE 56 design an experiment to test the effects of light, water, or force of gravity on roots and stems of plants.

L11: Children shall have opportunities to identify relationships among living things.

The learner will:

LIFE 57 explain how plants and animals benefit from each other.

LIFE 58 make a chart of a simple food chain (e.g., plant-insect-bird).

LIFE 59 investigate the relationships animals and plants (e.g., monarch which exist between specific butterflies and milkweed, roses and aphids, bees and orchards, budworm and spruce trees, codling moth and apples).

LIFE 60 describe the care given by a common animal to its young.

LIFE 61 investigate the behaviour of a social animal (e.g., bees, ants, bison).

LIFE 62 investigate how animals are protected from their predators.

PEOPLE IN THE ENVIRONMENT

L12: Children shall have opportunities to investigate ways in which people affect plant and animal life.

The learner will:

LIFE 63 classify the behaviours of animals that are helpful and harmful to humans and give reasons for your decisions.

LIFE 64 investigate and report on how nature and humans control animal populations.

LIFE 65 investigate the effects of human activity (e.g., logging, clearing and draining of land, using pesticides, removing individual species, creating monocultures) on the environment.

LIFE 66 investigate how an urban area affects the plants and animals that live there.

LIFE 67 investigate the disadvantages to the environment of the use of such products as fertilizers, cosmetics, pesticides, paints, and plastics.

L13: Children shall have opportunities to investigate human dependence on plants and animals.

The learner will:

LIFE 68 investigate the importance of plants and animals in the environment.

LIFE 69 explain how people are dependent on the natural environment.

LIFE 70 identify plants that are used as food for people.

LIFE 71 identify and explain uses of flowers and fruits.

LIFE 72 investigate a variety of uses of seeds.

LIFE 73 describe the dependence of people on a common animal.

LIFE 74 investigate how animals contribute to the livelihood of people in Ontario.

LIFE 75 identify how myths, legends, and folklore show human dependence on animals and plants.

L14: Children shall have opportunities to identify and describe several machines used in cultivating, processing, harvesting, storing, or transporting plant or animal products.

The learner will:

LIFE 76 identify and describe the equipment used in bringing an animal or vegetable product from its origin to its end use.

LIFE 77 describe the function of some machines used in agriculture, forestry, and fishing.

LIFE 78 classify agricultural machines according to how they are used.

LIFE 79 investigate Canadian contributions to agriculture.

THE HUMAN BODY

L15: Children shall have opportunities to develop an awareness of the human body, including its needs, its systems, and its systems' functions.

The learner will:

LIFE 80 investigate the five senses of the human body and their functions.

LIFE 81 identify the human body systems and describe their functions.

LIFE 82 determine the needs of the human body through personal observation and experience.

LIFE 83 investigate rules and practices to maintain good health.

L16: Children shall have opportunities to identify–and examine, if appropriate–devices that aid in the observation and care of the human body.

The learner will:

LIFE 84 examine and identify devices used to observe, measure, and monitor human bodily functions.

LIFE 85 construct and use simple devices that aid in the observation and care of the human body.

L17: Children shall have opportunities to develop an awareness of human diseases and disabilities.

The learner will:

LIFE 86 identify some needs of persons with different diseases and describe means by which they overcome the effects of their diseases.

LIFE 87 identify some needs of persons with different disabilities and describe methods they use to adapt to daily life.

LIFE 88 investigate ways of assisting the disabled.

LIFE 89 investigate Canadian contributions in medicine.

L18: Children shall have opportunities to become aware of equipment that assists disabled people.

The learner will:

LIFE 90 design a device to assist a person with a disability.

LIFE 91 identify ways in which the community assists disabled people.

EARTH AND SPACE SCIENCE

THE EARTH

E01: Children shall have opportunities to design and conduct experiments involving the properties and functions of particles and liquids.

The learner will:

ERSP 01 design and conduct experiments to investigate the states of water.

ERSP 02 explore the effects of the formation of ice on the environment (including living things).

ERSP 03 observe and describe both the solution and the crystals during their growth and determine conditions which will encourage crystal formation.

ERSP 04 design and conduct experiments involving particles.

E02: Children shall have opportunities to investigate at least one of the following from the local environment: rocks and minerals, fossils, soils.

The learner will:

ERSP 05 observe and describe some characteristics of rock and mineral samples (e.g., texture, colour, shape, size).

ERSP 06 classify rock and mineral samples based on student-developed criteria.

ERSP 07 give simple descriptions of the formation of three basic types of rock (igneous, sedimentary, metamorphic).

ERSP 08 describe how rocks can change to soils.

ERSP 09 list ways in which people use rocks and minerals.

ERSP 10 investigate the various methods used to mine or extract material resources from the earth, and the methods used to reduce the environmental impact.

ERSP 11 identify industries that have developed in Ontario as a result of rocks and minerals.

ERSP 12 investigate and observe soils in the local environment.

E03: Children shall have opportunities to use devices appropriate to the investigation of rocks and minerals, fossils, or soils.

The learner will:

ERSP 13 investigate and use equipment and materials associated with the investigation of rocks, minerals, and fossils.

ERSP 14 demonstrate through simulation ways of removing a fossil from surrounding rock.

ERSP 15 develop and use a simple classification key for a given set of rocks and minerals.

ERSP 16 make and use a variety of equipment to aid in obtaining and studying soil.

ERSP 17 describe and demonstrate how materials beneath the earth's surface are located.

THE ATMOSPHERE

E04: Children shall have opportunities to observe and describe a variety of weather conditions and suggest ways of predicting weather.

The learner will:

ERSP 18 observe and describe weather in terms of changes in temperature, air pressure, humidity, wind speed and direction, and precipitation.

ERSP 19 observe weather over an extended period of time and note patterns.

ERSP 20 describe the conditions of the sky and relate them to the weather.

ERSP 21 explain how clouds are formed.

ERSP 22 use a barometer to measure air pressure.

ERSP 23 observe and describe the characteristics of snow.

ERSP 24 use a camera and time-lapse photography with differing time intervals to record changes in the weather (e.g., pictures of cloud patterns recorded every ten minutes).

ERSP 25 identify and explain the symbols on a simple weather map.

ERSP 26 predict the weather.

ERSP 27 test the validity of folklore in predicting weather.

E05: Children shall have opportunities to design, construct, and use simple weather instruments.

The learner will:

ERSP 28 design, construct, and use a thermometer to measure the temperature of the air.

ERSP 29 design, construct, and use a rain gauge to measure rainfall.

ERSP 30 design, construct, and use an anemometer to measure wind speed.

ERSP 31 design, construct, and use a wind vane to determine wind direction.

E06: Children shall have opportunities to identify ways in which weather conditions affect their lives.

The learner will:

ERSP 32 investigate wind patterns in a local area.

ERSP 33 investigate and predict the melting and freezing patterns in a local area.

ERSP 34 investigate how weather conditions affect the evaporation of moisture (e.g., the drying of clothing on a clothes line).

ERSP 35 investigate how mini-climates in and around the school yard affect student activities.

ERSP 36 describe and compare the characteristics of intense weather disturbances (e.g., tornado, hurricane, hailstorm) and describe safe actions to be taken during a severe weather disturbance.

ERSP 37 identify those parts of the body which are most affected by cold.

ERSP 38 describe and compare some occupations or careers that are affected by weather.

ERSP 39 recognize and explain how weather affects rural and urban people in Ontario.

ERSP 40 recognize and describe some of the effects that weather has on communications systems.

E07: Children shall have opportunities to become aware of devices that people use to adapt to various weather conditions and examine these devices when appropriate.

The learner will:

ERSP 41 observe the effect sand and salt have upon ice, and relate this to winter driving conditions and the environment.

ERSP 42 name various materials and devices that protect people from direct sunlight.

ERSP 43 investigate how a greenhouse simulates a natural growing environment.

ERSP 44 research and report on the function of a lightning rod, and observe such devices where appropriate.

ERSP 45 investigate how fog horns, fog lights, and radar are used to help adapt to local weather conditions.

ERSP 46 identify machines and methods used to imitate weather conditions (e.g., snow-making machines, cloud seeding).

E08: Children shall have opportunities to use appropriate materials to explore the nature and movement of air.

The learner will:

ERSP 47 demonstrate that air expands as it is warmed and contracts as it is cooled.

ERSP 48 demonstrate that air is constantly moving.

ERSP 49 construct flying devices using a variety of materials.

ERSP 50 identify and manipulate the variables that affect the performance of flying devices (e.g., parachutes, gliders, kites).

TIME AND TIME RELATIONSHIPS

E09: Children shall have opportunities to estimate and measure time to the nearest hour, minute, and second.

The learner will:

ERSP 51 estimate and measure time to the nearest hour, minute, and second.

E10: Children shall have opportunities to design, construct, and calibrate a device to measure units of time.

The learner will:

ERSP 52 make and use some simple devices for measuring time (e.g., sundial, sand timer, salt timer, water drop timer, candle clock, and pendulum clock).

E11: Children shall have opportunities to match events to appropriate units of time.

The learner will:

ERSP 53 choose and use appropriate units of time and appropriate devices for measuring different events.

ERSP 54 identify the appropriate uses for a particular type of timing device.

E12: Children shall have opportunities to identify and use devices for measuring particular units of time.

The learner will:

ERSP 55 use calendars as a recording device for appropriate events.

ERSP 56 identify ancient and modern devices used to measure time.

E13: Children shall have opportunities to observe cyclical occurrences in their lives and in the natural world.

The learner will:

ERSP 57 observe and record the activity/rest cycles of humans.

ERSP 58 investigate a food chain as part of a cyclical process in the natural world.

ERSP 59 observe and record cyclical occurrences in astronomy.

ERSP 60 demonstrate an understanding of the units of time associated with the movements of the earth and of the moon.

ERSP 61 investigate the water cycle as the continuous process of evaporation, condensation, and precipitation.

ERSP 62 identify some of the effects that seasonal changes have on animals and plants.

E14: Children shall have opportunities to develop time lines to track and record observed events of a scientific nature.

The learner will:

ERSP 63 observe and arrange routine scientific events in proper sequence.

ERSP 64 recognize a time line as a chronological record of a series of events.

E15: Children shall have opportunities to identify and use devices for tracking and recording scientific events.

The learner will:

ERSP 65 identify and use devices for tracking and recording scientific events (e.g., tape recorder, camera, calendar, computer)

E16: Children shall have opportunities to estimate and measure distances and the time that objects take to traverse them.

The learner will:

ERSP 66 design and conduct experiments to investigate the factors that affect the movement of objects.

E17: Children shall have opportunities to use time as a variable in an experiment.

The learner will:

ERSP 67 design and carry out experiments using time as a variable.

ERSP 68 recognize that time is a variable in the change process (e.g., decaying, rusting, growth).

EARTH, SUN, AND MOON

E18: Children shall have opportunities to develop an awareness of the movement of the earth that results in day and night and the seasons.

The learner will:

ERSP 69 develop an awareness of the movement of the earth in relation to the sun.

ERSP 70 develop an awareness of the day and night skies to better understand the movement of the earth within the solar system.

ERSP 71 develop an awareness of measurement devices which are used to track the movement of the earth.

ERSP 72 develop an awareness of the number of hours of daylight in different parts of the world at the same time.

ERSP 73 develop an awareness of the temperatures at different places on the earth at the same time.

E19: Children shall have opportunities to develop an awareness of the earth, moon, and sun and, when appropriate, observe phenomena such as eclipses and phases.

The learner will:

ERSP 74 observe, identify, and illustrate the difference in the moon's appearance and position over time.

ERSP 75 devise a demonstration to explain why the moon's phases occur.

ERSP 76 devise a demonstration to illustrate the conditions necessary for an eclipse of the moon to occur.

ERSP 77 observe the surface of the moon using the naked eye, binoculars, or a telescope.

ERSP 78 describe some of the conditions on the moon.

ERSP 79 observe and compare photographs of the moon and the earth.

ERSP 80 use diagrams or models to represent the position of the sun, earth, and moon during an eclipse of the sun.

E20: Children shall have opportunities to develop an awareness of challenges related to travel in space.

The learner will:

ERSP 81 identify the characteristics of space which make travel difficult (e.g., lack of water and oxygen, apparent weightlessness, and distance).

ERSP 82 identify and discuss the normal human functions which are affected by the apparent weightlessness of space travel (e.g., eating, dressing, movement, bathing, and elimination).

ERSP 83 name some of the things that an astronaut must be trained to do before travelling into space (e.g., work and co-operate with others, handle weightlessness, problem-solving).

ERSP 84 identify and compare problems of survival faced by explorers on the earth with those of modern space travellers.

ERSP 85 investigate various methods devised for manoevering outside a spacecraft and suggest other methods.

ERSP 86 identify the advantages and disadvantages of peopled spaceflight versus unpeopled spaceflight.

ERSP 87 predict ways in which people may use space in the future.

E21: Children shall have opportunities to investigate products that people use to deal with the challenges of space travel.

The learner will:

ERSP 88 identify devices and techniques that accommodate working, studying, teaching, eating, sleeping, drinking, and washing in a weightless environment.

ERSP 89 investigate the design of a spacesuit to identify some of its features and purposes.

ERSP 90 explain how computers have made space travel possible.

ERSP 91 determine the applications of lasers, both in space and on the earth.

ERSP 92 demonstrate how solar energy is used to power electrical equipment.

ERSP 93 evaluate the utilization of space shuttles compared with non-reusable space vehicles.

ERSP 94 identify and discuss how spinoffs from space technology have improved life on the earth.

ERSP 95 investigate the contributions made by Canada, the United States, the former Soviet Union, and Europe to working and living in space.

PHYSICAL SCIENCE

MATERIALS AND SUBSTANCES

P01: Children shall have opportunities to design and build structures using common materials.

The learner will:

PHYS 01 design and construct a free-standing tower using common materials.

PHYS 02 identify the effects of variables, such as shape and materials, on the strength of a structure.

PHYS 03 classify structures in the community according to design and materials.

PHYS 04 construct and use a simple turbine or water wheel.

P02: Children shall have opportunities to investigate the physical properties of one or more materials.

The learner will:

PHYS 05 use the appropriate senses to describe an object.

PHYS 06 recognize some similarities and differences of items in a set of materials and/or substances.

PHYS 07 classify materials and/or substances, using the appropriate senses.

PHYS 08 compare the physical properties of a variety of samples of consumer products (e.g., paper towels, adhesive tape, string, J-cloths, cosmetics, desposable diapers).

PHYS 09 match the properties of common objects to their uses.

PHYS 10 experiment with various substances to determine the ability of water to act as a solvent.

PHYS 11 list differences between fresh and ocean water.

PHYS 12 investigate how an object floats in different liquids (e.g., water, milk, vinegar, soda water, shampoo, glycerine, salt water).

PHYS 13 conduct experiments to compare different liquids.

PHYS 14 investigate the properties of gases (e.g., air, carbon dioxide).

PHYS 15 predict and investigate the changes that may take place in materials.

P03: Children shall have opportunities to design and perform an experiment in which a particular property is compared and measured in two or more objects.

The learner will:

PHYS 16 investigate and compare the rate of liquid absorption in materials.

PHYS 17 perform experiments to classify materials as either attracted or nor attracted by magnets.

PHYS 18 test and classify materials of similar thickness through which magnetic forces will or will not act.

PHYS 19 classify materials as to whether they emit or reflect light.

PHYS 20 design and perform tests to determine which surfaces best absorb radiant energy.

PHYS 21 design an experiment to classify materials as electrical conductors or non-conductors.

MEASUREMENT

P04: Children shall have opportunities to use appropriate measuring devices employing standard and non-standard units.

The learner will:

PHYS 22 estimate and measure lengths, masses, volumes, and temperatures of common items using standard and non-standard units.

PHYS 23 identify appropriate methods to estimate and measure lengths, masses, volumes, and temperatures of common items using standard and non-standard units.

PHYS 24 identify problems associated with the lack of standard measuring devices.

PHYS 25 use spring scales to measure pushes and pulls.

P05: Children shall have opportunities to design, construct, and calibrate a measuring device.

The learner will:

PHYS 26 design, construct, and calibrate devices to measure time, length, volume, mass, force, and temperature.

PHYS 27 evaluate the usefulness and appropriateness of measuring devices.

CAUSE AND EFFECT RELATIONSHIPS

P06: Children shall have opportunities to explore and experiment with ways in which a material can be changed naturally.

PHYS 28 observe and record evidence of natural change in the environment.

The learner will:

PHYS 29 observe, predict, and investigate ways in which materials change, and investigate the factors affecting the rate of change.

P07: Children shall have opportunities to identify products and processes used to preserve materials.

The learner will:

PHYS 30 identify products and processes used to preserve materials.

PHYS 31 compare products and processes used to preserve material today with those used in pioneer times.

P08: Children shall have opportunities to design and perform an experiment to explore a cause-and-effect relationship.

The learner will:

PHYS 32 observe that air can cause objects to move and investigate why.

PHYS 33 test the mass-carrying capacity of a boat by adding uniform masses until the boat sinks.

PHYS 34 investigate how the pitch of an instrument can be altered.

PHYS 35 construct and compare open and closed circuits.

PHYS 36 investigate how dry cells influence the brightness of a bulb.

PHYS 37 construct and investigate the use of a fuse in a simple circuit.

PHYS 38 investigate factors that affect rates of change.

PHYS 39 construct pendulums and investigate the factors affecting their swings.

PHYS 40 determine conditions which will encourage crystal formation.

MACHINES

P09: Children shall have opportunities to construct devices incorporating one or more simple machines and experiment with them.

The learner will:

PHYS 41 identify and collect examples of levers, pulleys, wheels and axles, inclined planes, screws, and wedges, and investigate how these simple machines alter the force required to move an object.

PHYS 42 investigate friction using simple machines.

PHYS 43 build a device using simple machines.

PHYS 44 construct a simple machine and change part of it to make it work more easily.

P10: Children shall have opportunities to identify and use everyday devices that incorporate simple machines.

The learner will:

PHYS 45 identify some common examples of simple machines in the environment.

PHYS 46 investigate the uses of simple machines in toys.

PHYS 47 use simple machines to perform a task.

PHYS 48 identify the gears in everyday devices and discover their role in making work easier.

PHYS 49 observe a variety of compound machines and identify the simple machines that are used in their operation (e.g., wheelbarrow, door latch, can opener, fishing pole, bicycle).

ENERGY

P11: Children shall have opportunities to explore the characteristics and properties of one or more forms of energy.

The learner will:

PHYS 50 draw a picture to show the path that light travels for an object to be seen.

PHYS 51 predict and investigate the path of a ray of light when it is reflected from a flat mirror.

PHYS 52 investigate what happens to light when it passes from one medium to another.

PHYS 53 investigate colour as a property of light.

PHYS 54 investigate how sound is produced and sound is transmitted.

PHYS 55 investigate sounds and group them according to pitch and loudness.

PHYS 56 investigate attraction and repulsion using magnets.

PHYS 57 identify and compare the fields of force around different magnets.

PHYS 58 construct and test magnets and electromagnets.

PHYS 59 investigate the effect of an electrical current on a magnetic compass.

PHYS 60 use free-moving magnets and magnetic compasses to find the Earth's magnetic north.

PHYS 61 explore how objects and surfaces can be charged.

PHYS 62 investigate experiences in everyday life that involve static electricity.

PHYS 63 classify surfaces as to whether they will attract of repel a charged object (e.g., inflated balloon, comb, pith, paper).

PHYS 64 identify the forms of energy used in the school and home.

P12: Children shall have opportunities to identify devices or substances that involve a particular form of energy.

The learner will:

PHYS 65 examine and explore a variety of musical instruments to determine how they make sound.

PHYS 66 identify devices that use magnets or electromagnets (e.g., motor, telephone).

PHYS 67 identify, construct, and compare series and parallel circuits and name their components.

PHYS 68 read and draw diagrams that illustrate various electrical circuits.

PHYS 69 identify, name, and discuss safe and unsafe uses of electricity

PHYS 70 identify items in and around the home and school which use energy.

PHYS 71 classify household appliances according to the amount of energy they use.

PHYS 72 investigate the operation of the heating and cooling systems of a school.

PHYS 73 investigate the energy devices used in rural Ontario in the past and present.

P13: Children shall have opportunities to explore the conversion of energy from one form into another.

The learner will:

PHYS 74 investigate how human beings and animals produce sounds.

PHYS 75 construct a working wet cell and demonstrate its operation.

PHYS 76 perform tests with hand generators to find the relationship between how fast the handle is turned and the amount of electricity produced.

PHYS 77 investigate ways that Ontario uses turbines to produce energy.

PHYS 78 investigate activity and motion as they relate to energy.

PHYS 79 investigate how people use solar energy.

PHYS 80 describe ways in which plants become a source of fuel (e.g., coal, peat, methane gas, manure, food).

P14: Children shall have opportunities to identify materials or objects in which the conversion of energy occurs.

The learner will:

PHYS 81 construct a simple musical instrument and use it to play a tune.

PHYS 82 demonstrate that electrical energy flowing through a conductor may generate heat.

PHYS 83 identify the energy converters used in the school and home.

PHYS 84 construct and use a device which captures the sun's energy (e.g., hot dog cooker, hot water heater, terrarium, silicon cells).

PHYS 85 explore devices that use wind as a source of energy.

ENERGY RESOURCES AND THE ENVIRONMENT

P15: Children shall have opportunities to demonstrate concern and care for the environment (e.g., repair dripping faucet; collect paper, aluminum cans, or bottles for recycling).

Note: Learning opportunity is also found in the Life Science component (L01); however, the examples are different.

The learner will:

PHYS 86 investigate and identify the major causes of heat loss from the school building.

PHYS 87 name and discuss ways to alleviate existing pollution problems.

PHYS 88 construct air particle collectors to measure air pollution.

PHYS 89 investigate the ways water is prepared for human consumption.

PHYS 90 give examples of human and natural pollution and identify ways to alleviate human pollution.

PHYS 91 describe ways to be actively involved in caring for the environment (e.g., air, land, water).

PHYS 92 identify some of the personal and environmental changes caused by the use of technology (e.g., radio, walkman, garbage bags, automobile, refrigerator, public transportation, furnace, wood stove, micro-chips, lasers, liquid crystals, digital thermometers, fibre optics, scratch and sniff).

P16: Children shall have opportunities to identify devices used to conserve energy.

The learner will:

PHYS 93 describe changes that could be made in places such as homes, schools, businesses, and industries to conserve energy.

P17: Children shall have opportunities to demonstrate their role in the wise use of energy.

The learner will:

PHYS 94 classify waste materials according to their component substances and show the applications to garbage collection.

PHYS 95 examine current issues concerning pollution.

PHYS 96 identify strategies for student involvement in energy conservation.

PHYS 97 predict and discuss lifestyle changes if we had to do without electricity.

Appendix B

SCIENCE SKILLS

The skills included in this section are taken from page 20 of *Science Is Happening Here*. Depending upon the Science activity, each Science skill may be applied on its own, as part of the more complex skill of experimenting, or as part of other problem-solving models. Teachers should also be aware that these Science skills are interrelated and interdependent.

For each skill, a list of indicators has been prepared to assist teachers in assessing student development. No attempt has been made to list the indicators for each skill in any order of importance. Each indicator within a given skill has been arbitrarily assigned a code to assist in referring to specific indicators. Also, the lists of indicators are **not** intended to be absolute. Teachers should create additional indicators that are applicable to their classroom needs.

Student observation sheets designed by teachers will assist in keeping records of each learner's progress in the development of skills. Refer to **Appendix E** for some examples of student observation sheets.

When teachers design their own student observation sheets, they should select only those skill indicators **most relevant** to the learning opportunities being addressed. It is best to select a few of the more pertinent indicators when designing a student observation sheet. Teachers should consider **all** the indicator lists when preparing student observation sheets.

Science Skill Indicators

This section provides classroom teachers with skill indicators to aid in the assessment of a wide range of skills (see *Science Is Happening Here*, page 20) used by students while they are involved in activity-based Science learning.

It is not necessary to make assessments of every student's use of a particular skill or individual component of a skill during a single Science activity or lesson. The development of skills can be evaluated, however, by observing students over a range of Science activities and lessons.

The skills that are most directly related to a particular item are indicated in the **Learning Domains** field of the instrument. For each skill, a list of indicators is provided in this appendix. From these lists, the teacher can select the indicators that are most relevant to the activity in the item; it is important to review the item in detail in order to identify the most appropriate indicators for the particular program and class.

Through the years from Grade 4 to Grade 6, the progress of individual students in skills development can be evaluated through the review of assessment records accumulated by each teacher. Not all of the specific skills indicators need to be assessed. Each teacher should identify a set of Science skill indicators for his or her specific classroom program.

Another effective use of skill indicators is to diagnose the present level of skill acquisition for each student and use this information to refine and revise the Science program to best meet the class's needs.

The identification and complexity of the Science skills selected depends on the specific learning situation, past experiences, and the maturation of the students. The skill indicators should not be considered linear or absolute. It is possible that an individual student could be assessed as being able to observe detail accurately during one activity, but as not observing with the same degree of accuracy in another. Further, a student may demonstrate the skill of observing patterns in form and behaviour in one activity but be unable to observe change over a period of time during a later Science event. Observation by the teacher over time and in varying contexts is important.

It takes a long time to develop skills, whether during Science instruction or in other subject areas. During the early stages, the development of skills should be monitored over a wide range of activities, and over several years. Continuing growth in skills development should be expected.

Skills development occurs in a sequence. Generally, students move through three broad stages in the use of skills: awareness, practice, and transfer.

1. **Awareness**

   This is the stage when the skill has been introduced to the learner for the first time. Learners at this stage, with teacher assistance, are able to:

   (a) describe the skill using their own terms or vocabulary, and

   (b) use the skill during an activity.

2. **Practice**

   This stage occurs when the skill has been used frequently in a learning situation. Learners are able to:

   (a) describe the steps used in performing the skill,

   (b) follow the steps as described (i.e., perform the skill),

   (c) reflect upon the skill as they are using it, and

   (d) evaluate the skill used and, if relevant, the product produced.

3. **Transfer**

   This stage is reached when the skill is successfully demonstrated in a new setting within an unfamiliar context. The learner has now internalized the skill and is able to select it from a repertoire of skills. Learners are able to:

   (a) use the skill in a new context,

   (b) use a modified version of the skill, and

(c) evaluate the skill used and, if relevant, the product produced in a new context.

In most cases in the Junior Division, students will be at the awareness and/or practice stage within an individual skill. An A (awareness) or P (practice) inserted on student observation sheets with anecdotal comments could be used to indicate a student's stage of growth.

Problem-solving involves complex processes that include the use of many of the more simple skills. In carrying out an investigation, a student attempting to find an answer to a problem will follow parts of or the complete process indicated in the chart below.

PROBLEM-SOLVING SEQUENCE	SAMPLE SKILLS FROM *Science Is Happening Here*
Identify and define a specific problem	Analyzing
Make a plan to solve the problem	Recording, making models, hypothesizing, predicting, inferring, controlling variables
Carry out the plan	Observing, recording, measuring, analyzing, experimenting
Develop an answer or solution	Inferring, interpreting
Communicate results	Communicating
Reflect upon the process and results	Evaluating

One problem-solving model is shown on page 43 of *Science Is Happening Here*; others can be found in *Shared Discovery* (page 9) and *Programming for the Gifted* (pages 134-145), two Ministry of Education publications. Teachers should select the most useful model for each specific situation and use a variety of problem-solving techniques throughout the year. Further, some children will not follow every step in a particular model but could still arrive at an effective solution. In some cases, students will start at different stages in a model. They may even use a blend of several models. By demonstrating and using a variety of problem-solving models and by reinforcing the steps within each model, teachers can be more assured that students will have a repertoire of starting points when facing unique problem-solving situations.

The acquisition of knowledge in Science is important, and teachers should be aware that skills are more readily developed when the knowledge to be acquired is meaningful and appropriate to the learner. The reverse is also true: when the skills are meaningful and appropriate, knowledge is more readily acquired.

Technology for children in the Junior Division Science program involves the application of Science in the child's world. Through the development of skills, children explore technology. Learners have opportunities to consider technology and the application of Science through the activities of manipulating, constructing, testing, and rebuilding of materials and structures. The use of technology and the application of Science are important implicit aspects of skills development. Applying Science is not, however, included as a separate skill in *Science Is Happening Here*. It is, instead, inherent as a major thread across all the skill areas.

OBSERVING

Observing involves the use of one or more of the senses, singly, in combination, or in a sequence, to gather first-hand information about the characteristics of objects, phenomena, or events. It is the indentification of qualities, quantities, colour, texture, smell, taste, form, and number.

Indicators for the skill
OBSERVING

The student:

OBS 1 uses two or more senses in combination.

OBS 2 observes events in appropriate sequence over a period of time (detects change).

OBS 3 uses a variety of objects to aid in his or her observations (e.g., measuring equipment and magnifiers).

OBS 4 identifies the most appropriate observations of an object, event, or phenomenon.

OBS 5 identifies the most appropriate equipment and/or materials to extend the senses.

OBS 6 observes for a specific purpose (e.g., looks for similarities or differences).

OBS 7 observes to see patterns in form or behaviour.

OBS 8 observes to see patterns of behaviour and change.

OBS 9

OBS 10

OBS 11

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

CLASSIFYING

Classifying involves the process of sorting objects, events, or conditions into groups, based on specific common characteristics, factors, elements, patterns, or schemes, devised by the observer.

Indicators for the skill
CLASSIFYING

The student:

CLA 1 uses simple criteria to sort.

CLA 2 uses simple criteria to classify objects, events, and phenomena into sets and subsets.

CLA 3 uses a combination of simple criteria to classify and sort.

CLA 4 recognizes that some methods of sorting are more useful than others.

CLA 5 determines, in advance, which sorting criteria will be most useful for a particular purpose.

CLA 6 uses the complex criteria of origin, behaviour, and change to sort or group.

CLA 7 uses simple criteria to construct keys.

CLA 8

CLA 9

CLA 10

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

SERIATING

Seriating involves the ordering or arranging of objects, events, or conditions in a specific sequence or series according to one or more distinguishing attributes (e.g., shortest to longest, lightest to heaviest).

Indicators for the skill

SERIATING

The student:

SER	1	arranges a group of items in a series.
SER	2	adds new things to a series.
SER	3	identifies additional criteria for seriating objects.
SER	4	adds new things to a set within a series.
SER	5	orders the objects in a set in another way.
SER	6	groups objects in more than one set, and orders each of the sets in a sequence.
SER	7	
SER	8	
SER	9	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

COMMUNICATING

Communicating involves the reception of information from a variety of sources by different means, and the expression of information in a variety of ways.

Indicators for the skill

COMMUNICATING

The student:

COM 1	uses a variety of charts, graphs, tables, drawings, computers, interviews, and other sources to gather information.
COM 2	gathers information using hands-on investigations.
COM 3	gathers and expresses information using a scientific approach.
COM 4	evaluates information for its validity and reliability.
COM 5	reshapes new information.
COM 6	uses charts, graphs, tables, drawings, computers, interviews, and other resources to express information.
COM 7	uses a variety of media in the reception and delivery of information.
COM 8	selects appropriate resources and media for the reception and expression of information.
COM 9	uses appropriate scientific language correctly.
COM 10	
COM 11	
COM 12	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

MEASURING

Measuring involves the determination of quantitative descriptions (length, area, mass, capacity, temperature, or duration) of things by comparing them with standard or non-standard units. (The standard or non-standard unit selected should offer reasonable precision for the task at hand.)

Indicators for the skill

MEASURING

The student:

MEA 1	recognizes what needs to be measured.
MEA 2	chooses the appropriate instrument for a measuring task.
MEA 3	selects the appropriate unit of measure for the task at hand.
MEA 4	estimates the measure.
MEA 5	measures more than once.
MEA 6	compares the estimation with the measurement.
MEA 7	accomplishes the measuring task with measurements that are close in value (precision).
MEA 8	accomplishes the measuring task with measurements that are close to the accepted value (accuracy).
MEA 9	relates and computes units of measure where necessary.
MEA 10	records measurements.
MEA 11	
MEA 12	
MEA 13	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

INFERRING

Inferring involves the projecting or the making of assumptions without directly observed information in order to identify what may be a truth.

Indicators for the skill
INFERRING

The student:

INF	1	recognizes that an event does not fit a known pattern.
INF	2	identifies possible causes for an unobserved event.
INF	3	identifies from past experiences what is known about similar events.
INF	4	identifies possible uses or functions for an object based on observations.
INF	5	recognizes the difference between observations and inferences.
INF	6	identifies how inferences are made.
INF	7	
INF	8	
INF	9	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

PREDICTING

Predicting involves the use of information in order to formulate a statement or to make decisions about what may happen.

Indicators for the skill
PREDICTING

The student:

PRE	1	makes reasonable predictions based on observations.
PRE	2	recognizes causal relationships from past experiences.
PRE	3	makes suggestions about the effects that a specific cause will produce.
PRE	4	suggests immediate and future changes when observing an event.
PRE	5	makes reasonable predictions based on related observations.
PRE	6	bases a prediction on a number of observations that have been viewed as a whole.
PRE	7	recognizes that the reliability of predictions depends on the reliability of observations.
PRE	8	makes predictions based on the recognition of a simple pattern in observations.
PRE	9	makes predictions based on complex patterns in observations.
PRE	10	generates simple {if...then} statements.
PRE	11	
PRE	12	
PRE	13	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

HYPOTHESIZING

Hypothesizing involves the making of possible explanations based on a number of observations and inferences.

Indicators for the skill
HYPOTHESIZING

The student:

HYP	1	makes simple hypotheses to explain observed or experienced events.
HYP	2	selects from several hypotheses the most likely explanation for given phenomena, events, or actions.
HYP	3	generates simple {if...then} statements, and explains the reasoning.
HYP	4	recognizes that hypotheses are possible explanations which have resulted from the consideration of careful observations and prior knowledge.
HYP	5	recognizes that all hypotheses are valid if based upon sound and reasonable analysis.
HYP	6	generates hypotheses for simple cause-effect events.
HYP	7	recognizes that information gathered in one investigation may be used to generate a hypothesis in another situation.
HYP	8	recognizes that hypotheses may be modified as new information is gathered.
HYP	9	
HYP	10	
HYP	11	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

EXPERIMENTING

Experimenting involves the designing and carrying-out of investigations to produce data which in turn are used to test predictions and hypotheses. (Experimenting uses various combinations of skills.)

Indicators for the skill
EXPERIMENTING

The student:

EXP	1	questions an event or phenomenon and/or identifies a problem(s).
EXP	2	clarifies and refines a problem for the purpose of investigation.
EXP	3	states, where appropriate, one or more possible explanations for the event, phenomenon, or problem.
EXP	4	selects the most likely explanation and states this in the form of a hypothesis.
EXP	5	identifies one or more variables.
EXP	6	designs and follows procedure(s) to test possible explanations and to control variables.
EXP	7	gathers and records data.
EXP	8	analyzes data for relationships.
EXP	9	repeats procedures to verify results.
EXP	10	makes conclusions.
EXP	11	communicates results.
EXP	12	
EXP	13	
EXP	14	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

CONTROLLING VARIABLES

Controlling variables involves the discovering, identifying, and manipulating of various conditions that may affect the outcome of an experiment.

Indicators for the skill

CONTROLLING VARIABLES

The student:

CVA	1	identifies one variable in a simple situation.
CVA	2	identifies two or more variables in a simple situation (e.g., variables affecting the growth of plants).
CVA	3	recognizes the importance of the identified variable(s).
CVA	4	demonstrates ways to manipulate a variable (e.g., colour of light on plant growth).
CVA	5	demonstrates ways to keep all variables constant (other than the manipulated variable).
CVA	6	recognizes more than two relevant variables in an investigation.
CVA	7	recognizes that a *fair test* cannot be carried out if the relevant variables are not controlled.
CVA	8	designs experiments using materials to demonstrate a means to controlling variables.
CVA	9	recognizes that more than one test are required to validate results more accurately.
CVA	10	
CVA	11	
CVA	12	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

INTERPRETING

Interpreting involves the development of conclusions based on the analysis of information that has been gathered.

Indicators for the skill
INTERPRETING

The student:

INT	1	gives simple explanations for different events.
INT	2	determines whether or not information gathered supports or refutes an explanation or hypothesis.
INT	3	formulates conclusions based on the results of a repeated test or experiment.
INT	4	analyzes observations and draws conclusions from direct experiences (primary sources).
INT	5	analyzes information from secondary sources (e.g., written material, audio-visual material).
INT	6	explains cause-effect relationships based on his or her own investigations (primary source information).
INT	7	recognizes that the validity of the conclusions made depends on the quality of the information gathered.
INT	8	
INT	9	
INT	10	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

MAKING MODELS

Making models involves the development and construction of a representation of an imagined or real object, system, or phenomenon, using materials which are readily available (e.g., paper airplane).

Indicators for the skill
MAKING MODELS

The student:

MOD 1 makes non-working models of real objects, systems, or phenomena.

MOD 2 carries out a simple procedure for making models.

MOD 3 makes working models of real objects, systems, or phenomena.

MOD 4 breaks down complex objects, systems, or phenomena into smaller components and makes models of these components.

MOD 5 makes pictorial representations of ideas.

MOD 6 makes written descriptions of how objects, systems, and phenomena work.

MOD 7 identifies differences and similarities between the model and the reality it represents.

MOD 8

MOD 9

MOD 10

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

MANIPULATING EQUIPMENT AND MATERIALS

Manipulating equipment and materials involves the handling of resources required for investigation in appropriate, safe, and creative ways.

Indicators for the skill

MANIPULATING EQUIPMENT AND MATERIALS

The student:

MEM 1 explores equipment and materials in meaningful ways.

MEM 2 manipulates equipment and materials with dexterity.

MEM 3 uses equipment and materials appropriately.

MEM 4 uses equipment and materials in innovative ways.

MEM 5 demonstrates confidence in using a variety of equipment and materials.

MEM 6 follows instructions for the correct use of equipment and materials when necessary.

MEM 7 uses equipment and materials in a safe manner.

MEM 8 takes care of equipment and materials and returns them to the appropriate location.

MEM 9

MEM 10

MEM 11

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

Appendix C

SCIENCE ATTITUDES

The attitudes for which indicators are suggested in this appendix are taken from page 20 of *Science Is Happening Here*.

For each attitude, a list of indicators has been prepared to assist teachers in recognizing student development in that particular attitude. No attempt has been made to list the indicators for each attitude in any order of importance. Each indicator within a given attitude has been arbitrarily assigned a code to assist in referring to specific indicators. Also, the lists of indicators are not intended to be absolute. Teachers should create additional indicators that are applicable to their classroom needs.

Student observation sheets designed by teachers will assist in keeping records of each learner's progress in the development of attitudes. Refer to **Appendix E** for some examples of student observation sheets.

When teachers design their own student observation sheets, they should select only those attitude indicators **most relevant** to the learning opportunities being addressed. It is best to select only a few of the more pertinent indicators, since using too many indicators at one time makes recording observations difficult. Teachers should consider **all** indicator lists when preparing student observation sheets.

Science Attitude Indicators

Students' values form the basis of how they work with others, determine how they make decisions, and influence how they form their life goals. Attitudes are developed when students consider personal and societal values as part of their learning experiences in the Science program, in the school, and in the classroom. Changing attitudes constantly redefine values. The attitudes outlined in *Science Is Happening Here* are best developed when integrated with the entire Junior Division program. Science offers unique opportunities for learners to develop and demonstrate appropriate attitudes and values.

The ways in which Science activities and learning experiences are managed by the teacher send strong values messages to the students and have a profound effect on the attitudes being developed by the learner. Teachers should be conscious of their position as a role model when they present Science lessons and demonstrations, when they act as facilitators of Science learning, and when they manage an activity-based learning environment.

Learners should see the Science attitudes being emphasized in the classroom, and the activities and management strategies selected should encourage the development of those attitudes. The indicators listed in this appendix can be used to monitor the development of Science attitudes as demonstrated by learners. Teachers should plan for attitude development during classroom Science programs.

Information in this appendix will assist teachers in planning Science activities and programs that encourage the development of attitudes during daily instruction. The identification and complexity of the Science attitudes selected depends on the specific learning situation, past experiences, and the maturation of the students. The attitudes indicators should not be considered linear or absolute. It is possible that an individual student could be assessed as developing well in a specific attitude in one Science activity but be assessed as not showing similar development in another.

It is not possible to observe and assess effectively the development of attitudes in every student during a single Science activity. By observing small groups of different students over a range of Science activities and using a personally modified observation sheet from Appendix E, a teacher can monitor the growth in the development of attitudes over several weeks. Long-term observations can be used in reporting student progress to parents.

The attitudes that are most directly related to a particular item are indicated in the **Learning Domains** field of the instrument. From the lists provided in this appendix, the teacher can select the indicators that are most relevant to the activity in the item. The items should be reviewed in detail in order to identify the most appropriate indicators for the class.

Through the years from Grade 4 to Grade 6, the progress of individual students in the development of attitudes can be assessed with the help of the constantly revised records of teachers. Not all of the indicators of individual attitudes need to be assessed. Each teacher can design a set of Science attitudes indicators for a specific classroom Science program, using the lists in this appendix as starting points.

CONCERN AND CARE FOR THE ENVIRONMENT

Concern and care for the environment are demonstrated when a learner acts in ways that reflect a nurturing ethic towards the earth.

Indicators for development in the attitude

CONCERN AND CARE FOR THE ENVIRONMENT

The student:

CCE	1	collects materials for observation and investigation only when appropriate.
CCE	2	reduces, re-uses, and recycles materials.
CCE	3	reduces the amount of energy required in his or her personal life.
CCE	4	interacts with the outdoors in a manner that causes the least damage to the environment.
CCE	5	keeps the environment clean by not littering or discarding polluting materials into drains or waterways.
CCE	6	co-operates by cleaning up the environment, where possible.
CCE	7	expresses appreciation and wonderment for the beauty and complexity of the natural environment.
CCE	8	enhances the environment by growing trees and other plants.
CCE	9	encourages others to grow trees and other plants.
CCE	10	
CCE	11	
CCE	12	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

RESPECT FOR LIVING THINGS

Respect for living things is demonstrated when a learner acts in ways that indicate a high value for life.

Indicators for development in the attitude
RESPECT FOR LIVING THINGS

The student:

RLT	1	shows pleasure in observing the behaviour and development of living things.
RLT	2	shows an awareness of the importance of living things.
RLT	3	recognizes the interdependence of all living things.
RLT	4	provides adequate care for plants and animals in the classroom and elsewhere.
RLT	5	returns living things to their original habitat.
RLT	6	demonstrates self-respect through a healthy life style.
RLT	7	demonstrates a respect for all other people.
RLT	8	
RLT	9	
RLT	10	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

CONSIDERATION FOR OTHERS

Consideration for others is demonstrated when a learner actively supports others.

Indicators for development in the attitude
CONSIDERATION FOR OTHERS

The student:

CFO 1 shares materials, equipment, and space during Science investigations.

CFO 2 co-operates with others in group activities.

CFO 3 listens to and considers the ideas of others.

CFO 4 recognizes and appreciates the efforts of others.

CFO 5 shares responsibilities for tasks during Science activities.

CFO 6 locates, brings, and shares materials and equipment with classmates.

CFO 7 returns equipment clean and in good and workable condition.

CFO 8 helps others when appropriate.

CFO 9

CFO 10

CFO 11

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

OPEN-MINDEDNESS

Open-mindedness is demonstrated when a learner objectively seeks and respects alternative views.

Indicators for development in the attitude

OPEN-MINDEDNESS

The student:

OPM 1 shows tolerance for the ideas, beliefs, and points of view of others.

OPM 2 appreciates the value and limitations of scientific investigations.

OPM 3 accepts the possibility of personal error in scientific investigations.

OPM 4 accepts the fact that one's personal conclusions to a scientific investigation could be in error.

OPM 5

OPM 6

OPM 7

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

OBJECTIVITY

Objectivity is demonstrated when a learner conducts investigations with an open mind and keeps personal bias in perspective.

Indicators for development in the attitude

OBJECTIVITY

The student:

OBJ 1 reserves judgments until all data have been considered.

OBJ 2 makes judgments based on information collected regardless of preconceived, personal opinions.

OBJ 3 clarifies and evaluates new information before using it.

OBJ 4 changes judgments as new, relevant information is made available.

OBJ 5

OBJ 6

OBJ 7

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

ACCURACY

Accuracy is demonstrated when a learner conducts an activity in a manner that produces a result that is close to an accepted standard.

Indicators for development in the attitude

ACCURACY

The student:

ACC	1	uses concepts and terms in the appropriate context.
ACC	2	searches for and selects the most appropriate instrument for investigations, observations, and measurement.
ACC	3	follows the approved procedures carefully.
ACC	4	records, translates, interprets, and communicates information with care.
ACC	5	measures carefully to produce a result that is close to the accepted standard.
ACC	6	
ACC	7	
ACC	8	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

THOROUGHNESS

Thoroughness is demonstrated when a learner considers and pursues all relevant aspects of an investigation.

Indicators for development in the attitude

THOROUGHNESS

The student:

THO 1 considers all aspects of an investigation in the planning process.

THO 2 follows directions and procedures completely.

THO 3 completes all steps and aspects of an investigation.

THO 4 repeats and/or modifies investigations where necessary.

THO 5

THO 6

THO 7

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

PERSEVERANCE

Perseverance is demonstrated when a learner actively pursues identified goals.

Indicators for development in the attitude
PERSEVERANCE

The student:

PER 1 persists with Science investigations until appropriate conclusions have been reached.

PER 2 attempts to overcome obstacles to the completion of investigations.

PER 3 continues with investigations when faced with distractions.

PER 4 looks for alternative approaches when the initial investigations prove unsatisfactory.

PER 5

PER 6

PER 7

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

SAFETY-MINDEDNESS

Safety-mindedness is demonstrated when a learner's actions reflect an internalized sense of safety needs.

Indicators for development in the attitude

SAFETY-MINDEDNESS

The student:

SAM 1 follows safety procedures consistently.

SAM 2 uses Science equipment safely.

SAM 3 foresees safety hazards and attempts to overcome them.

SAM 4 considers the safety of others when conducting investigations.

SAM 5 uses sources of safety information.

SAM 6 shares safety information with others.

SAM 7 alerts others to possible dangers when necessary.

SAM 8

SAM 9

SAM 10

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

CURIOSITY

Curiosity is demonstrated when a learner wants to know more about objects, events, ideas, and processes.

Indicators for development in the attitude

CURIOSITY

The student:

CUR 1 expresses a desire to find out what happened, and why.

CUR 2 asks questions about the world.

CUR 3 initiates further investigations.

CUR 4 communicates an interest in many things in a variety of ways.

CUR 5 invests personal time to pursue aspects of the world with which he or she is intrigued.

CUR 6 communicates an intrigue about aspects of the world where there is personal interest.

CUR 7

CUR 8

CUR 9

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

RISK TAKING

Risk taking is demonstrated when a learner shares or acts upon personal opinions, observations, intuitions, predictions, and questions.

Indicators for development in the attitude

RISK TAKING

The student:

RIT	1	demonstrates a willingness to take part in Science investigations.
RIT	2	demonstrates a willingness to participate in Science discussions and issues.
RIT	3	suggests alternative ideas and explanations.
RIT	4	subjects personal observations, conclusions, predictions, and hypotheses to the scrutiny of others.
RIT	5	shares personally-created products and performances.
RIT	6	shares predictions and hypotheses.
RIT	7	demonstrates a personal adjustment for change.
RIT	8	
RIT	9	
RIT	10	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

Appendix D

ADDITIONAL SCIENCE LEARNING PROCESSES

The learner and the learning environment outlined on pages 9 to 15 of *Science Is Happening Here* indicate the importance of: activity-based learning, learning as individuals and in groups, learning outdoors, and investigative problem-solving. The indicator lists in this appendix have been designed to elaborate on these types of learning situations and assist teachers in recognizing student development in them.

No attempt has been made to list the indicators in any order of importance. Each indicator within a Science learning situation has been arbitrarily assigned a code to assist in locating it. Also, the lists of indicators are **not** intended to be absolute. Teachers should create additional indicators that are applicable to their classroom needs.

Student observation sheets designed by teachers will assist in keeping records of each learner's progress within these Science learning situations. Refer to **Appendix E** for some examples of student observation sheets.

When teachers design their own student observation sheets, they should select only those indicators relevant to the learning opportunities being addressed. To facilitate observing and recording observations, it is best to select only a few of the more pertinent indicators when designing a student observation sheet. Teachers should consider **all** the indicator lists when preparing student observation sheets.

The most appropriate learning environment for Junior Division Science provides relevant experiences for the learner to explore the immediate surroundings and provides a foundation for future growth and learning. These experiences encourage children to become self-motivated, independent learners who are capable of being active participants in our society. In order to engage learners in an activity-based program, they must be involved in the planning, initiating, and conducting of the learning situations as partners with the teacher.

The indicator lists in this appendix have been developed to assist teachers with the planning, assessment, and evaluation of learning strategies used by students in an activity-based environment as outlined on pages 9 to 15 of *Science Is Happening Here*.

Students use a variety of print and non-print resources when seeking solutions to problems and when conducting experiments and investigations. The indicators for **Investigating from Primary Sources** and **Investigating from Secondary Sources** in this appendix are specially designed to offer guidelines and suggestions in the assessment of student performance in these areas.

The environment beyond the classroom and the school provides many valuable learning opportunities. In outdoor situations, students must follow unique safety and information-gathering procedures while working as individuals and as team members. The indicators in

the **Investigating in the Outdoors** listing are useful for the organizing and assessing of field-trip learning.

Often an investigation leads to the design, construction, and testing of a product as the solution to a specific problem. Science fairs, Science olympics, inventors' displays, and creative technology centres represent but should not limit learning situations that require students to apply a combination of attitudes, skills, and knowledge as they seek solutions to unique problems. The lists of indicators for **Creating and Using a Science Product** will support teachers in the application of related skills, attitudes, and knowledge when dealing with Science products in the regular program.

Teachers should use a variety of whole class, small group, and individual activities to maximize the Science learning in the classroom. **Learning Independently** and **Learning as a Member of a Group** contain progress indicators to support teachers in assessing students' development while learning in different social contexts.

The lists of indicators in this appendix are important aids in the preparation and delivery of a Science program which integrates Science learning across several subject areas and develops students who are lifelong, independent learners.

INVESTIGATING IN THE OUTDOORS

Outdoor investigations involve activities which do not occur inside buildings.

Indicators for assessing performance during
INVESTIGATING IN THE OUTDOORS

The student:

INO	1	contributes to the planning of the investigation.
INO	2	co-operates in the preparation of the required materials and equipment.
INO	3	explains the purpose, procedures, and safety considerations.
INO	4	collects specimens, if appropriate.
INO	5	records observations.
INO	6	shares information and perceptions with classmates.
INO	7	demonstrates a positive responsiveness to unexpected situations.
INO	8	acts in a responsible manner.
INO	9	shows respect for the environment.
INO	10	completes follow-up activities.
INO	11	contributes to the evaluation of the outdoor investigation.
INO	12	
INO	13	
INO	14	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

INVESTIGATING FROM PRIMARY SOURCES

Investigating from primary sources involves the gathering of information using 'hands-on' activities with living and non-living things.

Indicators for assessing performance while

INVESTIGATING FROM PRIMARY SOURCES

The student:

IPS	1	selects appropriate materials.
IPS	2	plans for the effective use of hands-on materials to acquire information.
IPS	3	follows directions if and when necessary.
IPS	4	follows appropriate problem-solving approaches.
IPS	5	asks relevant and probing questions throughout investigations.
IPS	6	repeats personal investigations and observations before discarding them for alternative explanations.
IPS	7	records the information in an appropriate manner.
IPS	8	maintains a safe and clean learning environment.
IPS	9	acts in a safe manner.
IPS	10	investigates living things in a humane manner.
IPS	11	investigates real things in a manner that demonstrates a care and concern for the environment.
IPS	12	
IPS	13	
IPS	14	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

INVESTIGATING FROM SECONDARY SOURCES

Investigating from secondary sources involves the gathering of information from sources such as: print materials, audio-visual aids, computers, interviews, and classroom visitors.

Indicators for assessing performance while
INVESTIGATING FROM SECONDARY SOURCES

The student:

ISS	1	uses two or more sources of information.
ISS	2	uses different types of resources.
ISS	3	selects the most appropriate sources of information.
ISS	4	selects the most relevant information.
ISS	5	reshapes information into new perspectives.
ISS	6	expresses the information in his or her own words.
ISS	7	organizes information appropriately.
ISS	8	presents information appropriately.
ISS	9	answers questions about the topic of interest.
ISS	10	
ISS	11	
ISS	12	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

LEARNING INDEPENDENTLY

Learning independently involves the development of skills and attitudes required to learn alone.

Indicators for assessing performance while
LEARNING INDEPENDENTLY

The student:

LEI	1	gathers the necessary resources.
LEI	2	uses time effectively.
LEI	3	stays on task.
LEI	4	seeks help when necessary.
LEI	5	accepts advice and suggestions for improvement of work.
LEI	6	modifies the work to improve the quality.
LEI	7	completes commitments.
LEI	8	takes pride in accomplishments.
LEI	9	
LEI	10	
LEI	11	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

LEARNING AS A MEMBER OF A GROUP

Learning as a member of a group involves the development of co-operative skills that enable a group to meet its goals.

Indicators for assessing performance while
LEARNING AS A MEMBER OF A GROUP

The student:

LMG 1	negotiates his or her roles and responsibilities.
LMG 2	contributes ideas and suggestions.
LMG 3	encourages the involvement of each member of the group.
LMG 4	shows a willingness to have his or her suggestions criticized or questioned.
LMG 5	modifies his or her ideas and suggestions when faced with new or better evidence.
LMG 6	listens to the ideas and suggestions of others.
LMG 7	accepts the talents and abilities of each group member.
LMG 8	recognizes the contribution of others and accepts it as an essential part of the group task.
LMG 9	modifies work to improve quality.
LMG 10	completes his or her commitments.
LMG 11	
LMG 12	
LMG 13	

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

CREATING AND USING A SCIENCE PRODUCT

Assessment and evaluation of the creation and use of a Science product, device, or model involves observing the process used from selection and design to completion and use, as well as examining the product's design, function, durability, operability, originality, and complexity.

Indicators for assessing performance while CREATING AND USING A SCIENCE PRODUCT

The student:

CUP 1 makes a product that addresses the intended purpose.

CUP 2 creates an operative product where required.

CUP 3 demonstrates creative thought in the design, construction, and use of materials.

CUP 4 tests the product for the purpose of improvement.

CUP 5 modifies the product for the purpose of improvement.

CUP 6 makes a product that is durable enough for the intended situation and use.

CUP 7 uses the product to address the situation or to solve the problem.

CUP 8 provides an appropriate explanation about the product to others.

CUP 9

CUP 10

CUP 11

See Appendix E (pages 95–131) for assistance in designing your own student observation sheets.

Appendix E

DEVELOPING STUDENT OBSERVATION SHEETS

Science Is Happening Here emphasizes an activity-based, enquiry-centred program. For effective Science learning, it is necessary to assess students and programs as learning occurs. Appendices B, C, and D of this **Assessment Planning Guide** contain sets of indicators which provide guidance for teachers as they plan assessment strategies for their students and programs.

Because of the unique circumstances of each class, teachers should select their own sets of indicators to use with their students and programs. This requires that teachers develop personalized **student observation sheets** for their Science themes.

The following three scenarios, one each for **Life Science**, **Earth and Space Science**, and **Physical Science**, have been written to illustrate the variety of approaches available for developing personalized student observation sheets. These scenarios provide contextual examples to be used as guidelines for the preparation of student observation sheets. They also demonstrate various planning approaches to the use of the indicators in an activity-based Science program.

Each scenario is composed of an initial description of a teaching-learning situation and examples of student observation sheets which relate directly to that teaching-learning situation. Following the third scenario is a collection of black-line masters of a variety of student observation sheets. These are intended as sample observation sheets for teachers to use while developing specialized observation sheets for their own classes. These sample observation sheets were designed originally with the skill, attitude, and other indicators in mind, but some could be used as they are and most could be adapted to provide space for recording assessment of progress with knowledge concepts.

Scenario Number One: LIFE SCIENCE

Lise Boisvert is a Grade 5 teacher in Northern Ontario. During the summer, she looked through the Science curriculum to start her long-term planning for the next school year. She chose springtime for the study of **natural habitats**. A unit had been developed by a curriculum committee of the local school board in accordance with the expectations of the policy statement *Science Is Happening Here*.

The next spring, Lise introduced the subject of habitats in her classroom to find out which investigations would be more relevant to her students. She also asked for suggestions of activities that would be of particular interest to them. She soon realized that her students' notions about habitats were rather vague, especially concerning the relationships between living things and the features of their habitats. She also learned that the students would like to go on a field trip to visit natural habitats. Lise decided the study was a good choice because her students needed practice in observing and recording observations in the outdoors. It was decided that they would explore an old logging road that crossed a hilly area and led to a small marsh.

The students were involved in the planning of the field trip. One of the boys suggested that his sister, a Biology student just returned from university, accompany the group. While the students were discussing group responsibilities, Lise defined a problem for them. She posed the question: "What are some of the conditions in a habitat that assure the survival of its plant life?" The students prepared the materials needed to gather and record information.

Upon their return from this outdoor activity, the students were required to compare and organize their information.

Lise planned her student assessment process to assess her students' skills and attitudes development in the outdoors. She referred to the **Junior Division Science OAIP** and, by looking up the keyword "habitat," retrieved a variety of useful instruments to assess the progress of her students. She decided to prepare an observation list to assess the progress of her students in skill areas such as recognizing pertinent observations and recording information. From the lists of indicators for **Observing, Investigating in the Outdoors**, and **Investigating from Primary Sources**, she selected the descriptions of observable behaviour that she needed to prepare her student observation sheets. She also gave the students a copy of an observation sheet for self-evaluation purposes. This enabled the students to see clearly what was expected of them.

The following are sample student observation sheets that Lise could have developed.

STUDENT OBSERVATION SHEET

CHECKLIST

TEACHER: LISE BOISVERT

YEAR: 199X - 9Y

STUDENTS / CRITERIA	INO 2	OBS 4	INO 4	CCE 4	IPS 10	COM 2	IPS 7	COM 3	INO 11				
1. JOEY A.													
2. CYNTHIA C.													
3. JAN C.													
4. MAI C.													
5. TAHA D.													
6. KLAUS F.													
7. MOËZ G.													
8. YU-MING L.													
9. AHMED N.													
10. FOO-YIP N.													
11. PASCAL P.													
12. MARIE R.													
13. SELINA S.													
14. FAYE T.													
15. CHANTAL W.													
16. LISE Y.													
17.													
18.													
19.													
20.													
21.													
22.													
23.													
24.													
25.													

Student Observation Sheet

RATED CHECKLIST

TEACHER: LISE BOISVERT

YEAR: 199X - 9Y

Name	Date	Criteria: PRIMARY SOURCES	Criteria: OBSERVING	Criteria: COMMUNICATING	Criteria: OUTDOORS
		Indicator: IPS 5	Indicator: OBS 7	Indicator: Com 9	Indicator: INO 9

RATING SCALE

NEEDS TO IMPROVE — SATISFACTORY — EXCELLENT

Student Self-Assessment Sheet

RATED ANECDOTAL

STUDENT:

ACTIVITY: HABITATS FIELD TRIP

TEACHER: LISE BOISVERT YEAR: 199X - 94

	Not Done	Partially Completed	Completed
I HELPED PLAN OUR INVESTIGATIONS. (INO 1)			
I FOLLOWED DIRECTIONS. (IPS 3)			
I RECORDED OUR OBSERVATIONS. (INO 5)			
I HELPED COMPLETE THE FOLLOW-UP ACTIVITIES. (INO 10)			
I RETURNED LIVING THINGS TO THEIR HABITAT, WHERE WE FOUND THEM. (RLT 5)			

Scenario Number Two: EARTH AND SPACE SCIENCE

Richard Greenwood is in his first year of teaching Grade 6 for a large urban school board. After reviewing *Science Is Happening Here* and the Science curriculum prepared through the program department of the board, Richard decided on a study of **weather** for his autumn Science program. Several of his students expressed an interest in meteorology, and one student's aunt was the on-camera weather person for a local television station.

Richard made a list of the major conceptual learnings to be covered and activities to be used and reviewed it with his students. Class discussions and some diagnostic questioning from Richard made it clear that the students needed experiences with observing and recording the weather. Many students were curious about how they could learn to predict the weather.

Richard ordered the weather kit containing equipment and materials from the board's Science Kit Centre and arranged a field trip to visit the student's aunt at the television station. Although the class had not had much experience working in groups, Richard saw this unit as an opportunity to introduce team work when the students were observing and recording weather phenomena. Recording atmospheric conditions using thermometers, barometers, and wind gauges would give the students opportunities to practise their measurement skills. Organizing the observations in tables and graphs would help to integrate Science with the Mathematics program. The students elected to compare their observations and predictions with those found in the newspaper and particularly those presented on television.

To help assess the progress of students in Science, the board's curriculum directed teachers to the **Junior Division Science OAIP**. The OAIP **Atmosphere** books contained a large selection of assessment instruments which Richard found useful for planning the conceptual scheme and for organizing the activities of the Weather unit. Richard knew that regular ongoing formative evaluation was an important component of learning and wanted to have the evaluation strategy fully synchronized with the planning for the unit. Because he shared the evaluation strategy with the students, everyone was clear about expectations. Richard found the activity-based instruments in the pool very helpful for preparing the learning centres for **Weather**. The **Learning Domains** field of these instruments also provided guidance on the kinds of skills and attitudes that students could develop during the activities.

Since each team was going to observe and record aspects of the weather, Richard identified the skills of **observing** and **measuring** as important for assessment. The need to use equipment on a daily basis for recording observations meant that student growth in the skill of **manipulating equipment and materials** should also be a part of the assessment. The strong interests of the students in learning how to predict the weather suggested that development in the skill of **predicting** would also be an important component in student learning.

The use of equipment and the taking of measurements would provide Richard with the opportunity to monitor student development in the attitude of **accuracy**. Since students would be working in teams while conducting observations and recording data, Richard would

be able to monitor and assess growth in the ability of students to have **consideration for others** while they worked in groups.

The **Assessment Planning Guide** directed Richard to Appendices B, C, and D for a detailed listing of the indicators of all the skills and attitudes that he had identified. Further assessment indicators for students working in groups were found in Appendix D. After referring to Appendix E, which showed how to use the indicators to develop student observation sheets for the classroom Science program, Richard was able to prepare student observation sheets directly related to the needs of the students in his classroom.

On the following pages are examples of student observation sheets that Richard could have developed for use during the unit on **Weather**.

STUDENT OBSERVATION SHEET

ANECDOTAL

TEACHER: RICHARD GREENWOOD YEAR: 199X-9Y

DOMAIN / CRITERION / ACTIVITY: GROUP WORK / WEATHER ACTIVITIES

TEAM: SHEREE, JOHANN, HSUE, SHAUN

Name	Date	Comments

Indicators

LMG 1 NEGOTIATES ROLE

LMG 10 COMPLETES COMMITMENTS

CFO 4 APPRECIATES OTHERS

CFO 8 HELPS OTHERS

PRE 3 SUGGESTS EFFECTS

MEM 7 SAFE USE

COM 4 EVALUATES INFORMATION

STUDENT OBSERVATION SHEET

RATED CHECKLIST

TEACHER: RICHARD GREENWOOD YEAR: 199X-9Y

DOMAIN / CRITERION: SCIENCE SKILLS / WEATHER ACTIVITIES

STUDENT:

Progress Indicators	Dates					
OBS 5 IDENTIFIES APPROPRIATE EQUIPMENT/MATERIALS						
OBS 8 PATTERNS of CHANGE						
MEA 2 CHOOSES APPROPRIATE INSTRUMENT						
MEA 7 ACCOMPLISHES TASK WITH PRECISION						
PRE 1 REASONABLE PREDICTIONS BASED ON OBSERVATIONS						
PRE 8 RECOGNIZES SIMPLE PATTERN IN OBSERVATIONS						
MEM 3 USES EQUIPMENT/ MATIRIALS APPROPRIATELY						
ACC 5 MEASURES CAREFULLY — REASONABLE RESULTS						
COM 6 USES A VARIETY OF FORMS TO EXPRESS INFORMATION						

CODES:

STUDENT SELF-ASSESSMENT SHEET

RATING SCALE

NAME:

ASSESSMENT OF: WEATHER ACTIVITIES

TEACHER: RICHARD GREENWOOD YEAR: 199X - 9Y

I FOLLOWED INSTRUCTIONS.	
I ESTIMATED THE TEMPERATURE AND THE RAINFALL.	
I DID THE MEASUREMENTS MORE THAN ONCE.	
I COMPARED MY ESTIMATES WITH THE MEASUREMENTS.	
I BROUGHT SOME WEATHER INFORMATION TO CLASS.	
I MADE SOME SUGGESTIONS TO MY TEAM.	
I CHANGED MY IDEAS WHEN WE GOT BETTER INFORMATION.	
I LISTENED TO MY TEAMMATES IDEAS.	

Scenario Number Three: PHYSICAL SCIENCE

Carol Powers is a Grade 5 teacher committed to co-operative unit planning with her students. Her class has been discussing a variety of questions about electricity and has become very motivated and excited about the topic. Based on the learning opportunities listed on page 31 of *Science Is Happening Here*, Carol engaged her class in a brainstorming exercise to identify knowledge, skills, and attitudes that could be featured in such a study. The class developed several flowcharts outlining investigations that they wanted to pursue.

Based on past studies, and with input from her class, Carol decided to concentrate on the skills of **experimenting** and **manipulating equipment and materials**. While past units had involved these skills, this would be the first unit to concentrate exclusively upon them. Carol was pleased that the students chose "**consideration for others**" as an attitude area of concentration, since, during the past two units, she had felt the students required some growth in this area. Carol decided that, since this study would strongly emphasize hands-on investigation of several questions, it would be an excellent opportunity to concentrate on attitudes relating to **perseverance**. This decision was explained to the class.

Once the overall decisions were formulated by Carol and her students, it was time to identify the criteria for assessment and evaluation. To start this process, Carol consulted Appendices B and C in the **Assessment Planning Guide** of the **Junior Division Science OAIP**. Indicator lists from the planning guide were reproduced on large sheets of experience chart paper and posted in the classroom. Each indicator was discussed with the class until everyone understood the skills and attitudes to be emphasized in the series of investigations. In order to formulate the details of each investigation, Carol found several assessment items pertaining to "electricity" in the OAIP **Energy** books very helpful to her. Once the activities were set up and the skills and attitudes clearly identified, the students were excited and ready to start the investigations.

Following are some sample student observation sheets that Carol might have developed to observe and record information about student growth during this study.

In order to concentrate on student growth over time, Carol included dates to chronicle accomplishments throughout the study.

Student Observation Sheet

ANECDOTAL

TEACHER: Carol Powers YEAR: 199x-94

DOMAIN AND CRITERION: SCIENCE SKILLS / EXPERIMENTING

STUDENT:

Date	Comments

INDICATORS

EXP 1 questions an event or phenomena and/or identifies a problem(s).

EXP 2 clarifies and refines a problem for the purpose of investigation.

EXP 3 states where appropriate, one or more possible explanations for the event, phenomenon, or problem.

EXP 4 selects the most likely explanation and states this in the form of a hypothesis.

EXP 5 identifies one or more variables.

EXP 6 designs and follows procedure(s) to test possible explanations and to control variables.

EXP 7 gathers and records data.

EXP 8 analyzes data for relationships.

EXP 9 repeats procedures to verify results.

EXP 10 makes conclusions.

EXP 11 communicates results.

EXP 12

EXP 13

STUDENT OBSERVATION SHEET

CHECKLIST

TEACHER: CAROL POWERS

YEAR: 199X-94

DOMAIN / CRITERION: SCIENCE SKILLS / MANIPULATING E. AND M.

Indicators →	MEM 2 MANIPULATES EQUIPMENT AND MATERIALS WITH DEXTERITY			MEM 6 FOLLOWS INSTRUCTIONS FOR CORRECT USE WHEN NECESSARY			MEM 4 USES EQUIPMENT AND MATERIALS IN INNOVATIVE WAYS			MEM 8 TAKES CARE OF EQUIPMENT AND RETURNS THEM		
Students \ Dates												

Student Self-Assessment Sheet

RATING SCALE

NAME:

ASSESSMENT OF: ELECTRICITY ACTIVITIES

TEACHER: CAROL POWERS YEAR: 199X-9Y

I cooperated with others.	
I listened to the ideas of others and considered them.	
I shared in the work.	
I used equipment and materials safely.	
I gathered and recorded data from our activities.	
I kept on working when there was a lot of noise and commotion around me.	
I returned equipment clean and in good condition.	

SAMPLE STUDENT OBSERVATION SHEETS: Black-Line Masters

Observation sheets are valuable devices for the continuous assessment of the progress of learners across a spectrum of skills, attitudes, and learning situations. It is especially important for teachers to chronicle these observations and to meet regularly and discuss progress of their students based on the information gathered on the observation sheets. Continuous assessment of this nature, coupled with ongoing feedback to the students as they are involved throughout the study, is vital to the assessment of Science learning. A teacher could design student observation sheets for one activity in a study, an entire unit of study, a term, or the whole year. Observation sheets should be used on an ongoing basis in order to assess learning growth over time.

The sheets which follow are black-line masters of sample student observation sheets. Teachers are encouraged to use these masters as models to design their own student observation sheets to suit their unique circumstances and the specific needs of their own classes, or to use them as they are if they are suitable for their students and their program needs.

Student observation sheets can take many different forms. A sheet can be designed to record the progress of an individual student, of a small group of individual students (either individually or as a team), or of all the students (individually) in a class. A student observation sheet could even be designed to record the progress of the whole class as a group.

A student observation sheet can be used to record the teacher's assessment, the student's self-assessment, or a student's assessment of a peer's achievements or a team's success. It can be used for a single criterion or for several criteria.

A student observation sheet may be primarily *anecdotal*, providing space for either brief or sometimes extensive comments. It may be basically a *checklist*, with a list of criteria being observed and space only to enter a tick ($\surd$) or a code. Some student observation sheets are made up of *rating scales*, one for each criterion being assessed. Others are combinations of more than one of these three basic types.

When designing a student observation sheet, specific labelled spaces should be provided for the following information:

1. Teacher's name
2. School year
3. Name(s) of the student(s)
4. Criterion/criteria (which may include a separate space for the term, unit or topic, activity, special purpose, or some other word or phrase to indicate the specific part of the curriculum)
5. Date of the observation
6. The comment, $\surd$, or code

When an observation sheet is being designed for a single activity or a short series of lessons, the teacher should be careful not to select too many criteria. It is difficult, if not impossible, to observe more than a few students and a few criteria in a single lesson. If a single observation sheet is to be used over a long period of time to record progress, each entry should be dated.

Even if an observation sheet provides only a small box for each entry, there are ways other than a simple $\surd$ or $\times$ in the box to provide additional information. Codes can be used to provide more specific information. Some sample code series are:

1. 0, 1, 2, 3, etc., with each number having a specific meaning, e.g., Not participating, Some participation, etc.
2. B = Beginning stages
   E = Early stages
   L = Later stages
   A = Advanced stages
   I = Independent stages
3. Box shadings: Divide the box into quarters and shade in the quarters (a) to indicate the level of achievement at a particular time or (b) to record gradual progress, box by box, over a period of time, the shading based on selected learning and levels of achievement.

The codings used in the boxes of a checklist are similar to the achievement levels on a rating scale. The rating scale may simply have numbers on it, with explanations of the numbers elsewhere on the form. Or the terms may be positioned at specific points or across particular spans of the scale. There is a wide variety of terms which can be used to indicate learning and levels of achievement. Some of these are:

1.			
2.	Not done	Partially completed	Completed
3.	Early development	Appropriate development	Advanced development
4.	Awareness (A)	Practice (P)	Transfer (T)
5.	Beginning	Middle	Advanced

Whatever terms are used to indicate the student's level of achievement or progress, a mark near the low end or in the middle indicates that the teacher should assess this criterion again. If the student is at or near the high end, it may not be necessary to check again.

Most of the sample student observation sheets included in this appendix were designed primarily to be used in assessing the skills and attitudes listed in *Science Is Happening Here* and also the additional learning processes covered in Appendix D of this book, but they can be adapted to cover knowledge concepts as well. There is also one for self-evaluation of written work, and a Science Tracking Sheet which can be used for a variety of purposes.

Domains (e.g., skills, attitudes), criteria (e.g., classifying, perseverance), learning processes (e.g., investigating from primary sources), indicators (e.g., uses simple criteria to sort), and activities have not been specified on these sheets. Indeed, these headings can be changed to others more appropriate for a specific use. Additionally, divisions, numbers, and terms have not been put on the rating scales. These omissions will make it easier for teachers to use and adapt these samples.

The three scenarios at the beginning of this appendix show how a few of these sample observation sheets can be used.

Student Observation Sheet

ANECDOTAL

TEACHER: _____ YEAR: _____

LEARNING OPPORTUNITY/OBJECTIVE(S): _____

STUDENT: _____

SKILLS	ATTITUDES	OTHER

Date	N O T E

Student Observation Sheet

ANECDOTAL

TEACHER: _____ YEAR: _____

DOMAIN AND CRITERION: _____

STUDENT: _____

Date	Comments

INDICATORS

Student Observation Sheet

ANECDOTAL

TEACHER: _____ YEAR: _____

DOMAIN AND CRITERION: _____

STUDENT: _____

Progress Indicators	Date	Comments

Student Observation Sheet

ANECDOTAL

TEACHER: _____ YEAR: _____

DOMAIN / CRITERION / ACTIVITY: _____

TEAM: _____

Name	Date	Comments

Indicators

_____

_____

_____

_____

_____

Student Self-Assessment Sheet

STUDENT: _____

ACTIVITY: _____

TEACHER: _____ YEAR: _____

	Not Done	Partially Completed	Completed

Student Self-Assessment Sheet

RATED ANECDOTAL

GROUP WORK
(Each person in a group or team should complete one of these forms.)

NAME: _____

PROJECT: _____

TEACHER: _____ YEAR: _____

Working Together

Answer these three questions on your own. Then use the questions and your answers to talk to others in your group about how you feel.

1. What do you think about your participation as a member of your group at this time? Please circle one of these comments:

I'm unhappy about it. It was okay. I really liked it.

Why did you circle this comment? _____

_____

_____

2. How do you feel about how successful the group was? Please circle one of these comments:

I'm unhappy about it. We could have done better. I feel great!

Why did you circle this comment? _____

_____

_____

3. What might you or your group do to improve the way your group works together?

_____

_____

_____

_____

Observation Sheets

Student Observation Sheet

CHECKLIST

TEACHER: _____ YEAR: _____

STUDENTS / CRITERIA ⇨													
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													
11.													
12.													
13.													
14.													
15.													
16.													
17.													
18.													
19.													
20.													
21.													
22.													
23.													
24.													
25.													

Student Observation Sheet

CHECKLIST

TEACHER: _____ YEAR: _____

DOMAIN / CRITERION: _____

Indicators ⇨												
Students \ Dates												

Student Observation Sheet

CHECKLIST

TEACHER: _____ YEAR: _____

SKILL/ ATTITUDE / OTHER																
Indicators ⇨																
Name	Date															

STUDENT SELF-ASSESSMENT SHEET

CHECKLIST

WRITTEN WORK

NAME: _____

TEACHER: _____ YEAR: _____

EVALUATING YOUR WRITTEN WORK

The following checklist will help you in assessing your notebooks and other written work.

NOTE: Use a (✓) to indicate that an area is satisfactory. Use an (x) to indicate that improvement is needed.

1.	My notes are complete.	☐
2.	My notes are accurate.	☐
3.	My notes are neat and uncrowded, so that a friend can read them.	☐
4.	Data sheets are placed in the order in which I completed them.	☐
5.	Diagrams are drawn neatly and are labelled.	☐
6.	New topics begin on a new page.	☐
7.	My notes include an up-to-date table of contents.	☐
8.	I have checked and corrected my spelling and grammar.	☐
9.		☐
10.		☐
11.		☐

Comments: _____

_____

_____

_____

_____

Student Observation Sheet

CHECKLIST

TEACHER: _____ YEAR: _____

SCIENCE TRACKING SHEET Name of Unit _____ STUDENTS												
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												
11.												
12.												
13.												
14.												
15.												
16.												
17.												
18.												
19.												
20.												

NOTES:

Student Observation Sheet

RATED CHECKLIST

TEACHER: _____ YEAR: _____

DOMAIN / CRITERION: _____

STUDENT: _____

Progress Indicators	Dates					

CODES:

Student Observation Sheet

RATED CHECKLIST

TEACHER: _____ YEAR: _____

Student																
Date																
Skill _____ Indicators _____ _____																
Skill _____ Indicators _____ _____																
Attitude _____ Indicators _____ _____																
Other _____ Indicators _____ _____																

RATING SCALE _____

STUDENT OBSERVATION SHEET

RATED CHECKLIST

TEACHER: _____ YEAR: _____

Name	Date	Criteria			
		Indicator	Indicator	Indicator	Indicator

RATING SCALE _____

Observation Sheets

Student Observation Sheet

RATED CHECKLIST

TEACHER: _____ YEAR: _____

Name	Date	Indicators	Criteria		
			_____	_____	_____

RATING SCALE

STUDENT OBSERVATION SHEET

RATED CHECKLIST

TEACHER: _____ YEAR: _____

Name / Domain/Criterion/Indicator														

RATING SCALE _____

Student Observation Sheet

RATING SCALE

TEACHER: _____ YEAR: _____

DOMAIN AND CRITERION: _____

STUDENT: _____

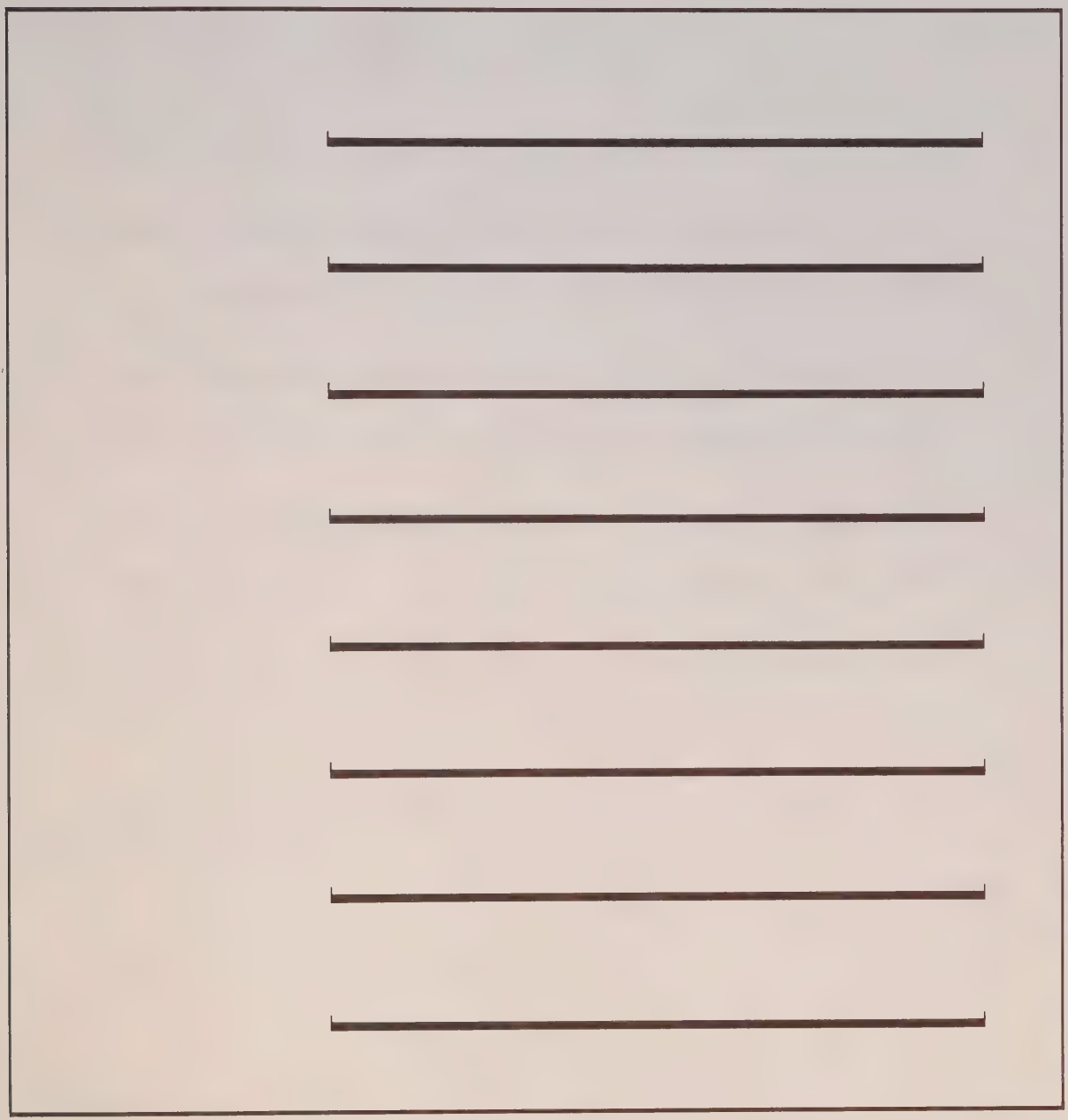
Student Self-Assessment Sheet

RATING SCALE

NAME: _____

ASSESSMENT OF: _____

TEACHER: _____ YEAR: _____



Group Self-Assessment Sheet

RATING SCALE

Group Work

NAMES: _____ _____

_____ _____

_____

TEACHER: _____ YEAR: _____

Please fill out this form together.

1.

Seldom ——— Always

2.

Seldom ——— Always

3.

Seldom ——— Always

4.

Seldom ——— Always

5.

Seldom ——— Always

Signatures: _____ _____

_____ _____

_____ Date: _____

Student Self-Assessment Sheet

RATING SCALE

Group Work

NAME: _____

PROJECT: _____

TEACHER: _____ YEAR: _____

1.

Seldom ——— Always

2.

Seldom ——— Always

3.

Seldom ——— Always

4.

Seldom ——— Always

5.

Seldom ——— Always

Comments / Suggestions: _____

_____

_____

_____

Signature: _____ Date: _____

Appendix F

SAFETY CONSIDERATIONS

Many of the activity-based instruments in the **Junior Division Science OAIP** require students to have experiences with equipment and materials. During any Science activity, learners in the Junior Division should exercise care and caution in the handling of glassware, equipment, chemicals, and sources of heat. One of the best safety advertisements is a well-prepared program whose "safety-mindedness" during Science learning occurs naturally. Appendix A of *Science Is Happening Here* indicates that it is the teacher's role to "model safe practices and communicate safety expectations to the children in accordance with school board and Ministry of Education policies." A positive, non-threatening attitude in a variety of Science learning situations will help develop a personal safety lifestyle among students.

Students should know how to handle glassware before they are permitted to proceed with activities. Procedures for the movement of glassware and for the clean-up of broken glass must be taught and followed. When chemicals are used, the students should be under close supervision and if, in the judgment of the teacher, the chemicals are hazardous, the activity should be a demonstration. Teacher demonstrations provide opportunities for students to see the safe handling of hazardous materials. Vinegar (10 per cent acetic acid), baking soda (sodium bicarbonate), pickling salt (sodium chloride), alum (aluminium potassium sulphate), food colouring, corn oil, and other kitchen cooking materials offer a wealth of chemicals safe for student use.

The use of open flames must be undertaken following Ministry and school board policies. With any open flame, extreme caution is needed to prevent hair and clothing from catching on fire. Hot plates, stoves, and microwave ovens, although somewhat safer than open flames, could raise the temperature of containers and fluids to a high enough level to cause second and third degree burns. Oven mitts and tongs should be used to secure hot containers when doing activities. For younger children, teachers should consider conducting a demonstration in some situations. Groups should be closely supervised while a flame is being used. Goggles should be worn when heating and observing hot liquids. The mixing of baking soda and vinegar causes a chemical reaction that may splash liquid into eyes. For chemical reactions like this, it is necessary to wear goggles.

When studying aromas or scents or identifying colourless unknown liquids, the "wafting" technique for sampling aromas should be used. Except in the case of foods, students should not taste materials or substances. Be aware of any students with allergies or potential allergic reactions to kitchen foods or chemicals used in the classroom. For example, some students are allergic to peanut oil.

Demonstrate the safe and proper use of sharp instruments and monitor the students closely while such instruments and tools are being used.

Some activity-based items require that students conduct outdoor Science activities. Adequate supervision is vital to safety in the out-of-doors. Be sure that the pupil/adult ratio is within school board policy.

The table below (**Some Poisonous Plants**) lists some of the poisonous plants which may be encountered by students in the school or on outdoor activities. Be sure that any plants being studied and handled by students are carefully identified and that any potentially poisonous situations are clearly explained to all students.

Non-domestic vertebrate animals carry diseases that can be transmitted to students. Caution is advised when handling these animals. Appropriate care of these animals and a prompt return to the natural environment or habitat are crucial. Further background and guidance on the use of animals in elementary classrooms can be found in *Science Is Happening Here*, Appendix B: Living Things in the Classroom (page 42).

Only in very limited and specific investigations have we pointed out safety aspects of an activity.

Some Poisonous Plants

The following list includes some poisonous plants that can cause: stomach and intestinal irritation (1); poisoning of the system (2); mouth and throat-lining irritation (3); skin irritation (4).

House Plants

caladium (1,3)
castor bean (1,2)
dieffenbachia (1,3)
elephant's ear (1,3)
lantana (2)
mistletoe (1,2)
philodendron (1,3)
poinsettia (4)

A number of other poisonous plants, which are not native to Canada, are also grown indoors.

Flower Garden Plants

autumn crocus, meadow saffron (2)
Christmas rose (1,4)
daffodil (1)
foxglove-leaves and seeds (2)
golden chair (2)
hyacinth (1)
iris, blue flag (1)
larkspur, delphinium (2)
lily of the valley (2)
monkshood (2)
morning glory (2)
narcissus (1)
snowdrop (1)
sweet pea-in large amounts (2)

Vegetable Garden Plants
potato-new shoots (2)
rhubart-leaf blade (2)

Field Plants
buttercup (1)
death camas (2)
false hellebore (2)
poison hemlock (2)
poison ivy (4)
pokeweed, inkberry (1,2)
snow-on-the-mountain (4)
thorn apple, jumson weed (2)

Trees and Shrubs
black locust (1,2)
cherry-twigs, leaves, and bark (2)
elderberry , black elder (2)
horse chestnut (1,2)
privet (1)

Ornamental Plants
daphne (1)
mountain laurel (2)
rhododendron (2)
wisteria (1)

Marsh Plants
cowslip, marsh marigold (1)
skunk cabbage (1,3)
water hemlock, cowbane (2)

Forest Plants
baneberry (1,2)
bloodroot (1,2)
deadly amanita (2)
fly agaric mushroom (2)
jack-in-the-pulpit (1,3)
May apple (1)
moonseed (2)
poison ivy (4)
poison oak (4)

The material in this table has been taken from *Science: Intermediate and Senior Divisions, 1987, Part 1, Program Outline and Policy*, pages 99 to 100. See also subsection 9.4, "The Safe Use of Plants," in the same document.

Appendix G

METRIC NOTATION AND EDITORIAL STYLE

1. Physical Quantities and Their Units

Name of Physical Quantity	Name of SI Unit	Symbol of Unit	Multiples and Sub Units	Other Units
length	metre	m	km	
			cm	
			mm	
area	square metre	m^2	km^2	ha
			cm^2	(hectare)
			mm^2	
volume	cubic metre	m^3	cm^3	L
				(litre)
	millilitre	mL		
time	second	s	ms	d (day)
				h (hour)
				min
				(minute)
				a (year)
speed,				
velocity	metre per second	m/s	cm/s	km/h
mass	kilogram	kg	g	t
			mg	(metric ton or tonne)
force	newton	N		
pressure	pascal	Pa	kPa	
temperature	degree Celsius	°C		
electric current	ampere	A	mA	
electric potential	volt	V	mV	

2. SI Prefixes

Multiplying Factor	Prefix	Symbol
$1000000 = 10^6$	mega	M
$1000 = 10^3$	kilo	k
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m

3. Metric Editorial Practice

The fundamental rules of style and metric editorial practice are important to ensure accurate observations and clear communication in Science. The above overview is intended as a quick reference for most situations in Junior Division Science. Detailed background reference information for all the standard SI metric units that can be used in Science activities and courses is found in Appendix B of *Science, Intermediate and Senior Divisions, 1987, Part 1, Program Outline and Policy* (pages 79 to 98). This is an excellent resource for the preparation of Science materials in the Junior Division.

The metric notations shown above represent the most commonly used quantities in the Junior Science program.

Appendix H

SENSITIVE ISSUES

1. The use of food (e.g., rice, corn, flax, milk, pasta, fruits, and vegetables) in Science activities or experiments should demonstrate an awareness of the importance of food in our daily lives. Care should be taken to minimize the waste of food or food stuffs during Science instruction and investigations. Packing materials and other manufactured materials can be substituted for grains in some activities, and the use of demonstrations rather than small-group activities when milk, fruits, vegetables, and other foods have to be used may be more appropriate.

2. The care and handling of animals in the classroom requires special attention. It is important to note that the use of vertebrate animals in the classroom is subject to the Ontario Animals for Research Act. Teachers are directed to the information on page 42 of *Science Is Happening Here*, Appendix B, which outlines requirements for the care of plants and animals. Teachers should also be aware of policies that school boards have developed as guides for the use of animals in the classroom. Consideration should be given to students with allergies prior to having mammals or birds in the classroom.

3. Some sensitive issues may be introduced through the spontaneous initiative or curiosity of students. The teacher shall ensure a sensitive and rational treatment of all issues and act as a role model in an environment of mutual respect. The teacher should assist students to:

   (a) develop, articulate, and reflect on their own points of view,

   (b) listen to and consider the views of others,

   (c) understand and appreciate all sides of an argument,

   (d) consider relevant information,

   (e) consider various interpretations of collected data or observed phenomena,

   (f) appreciate the possible ethical, cultural, racial, national, and religious implications of a point of view, and

   (g) grow intellectually.

4. Information that is provided about any sensitive issue should:

   (a) represent various scientific points of view in a way that minimizes prejudice,

   (b) reflect students' interests, needs, capabilities, and level of maturity,

   (c) reflect community concerns as well as provincial, national, and international implications,

   (d) reflect complementary or divergent perspectives that may be held by people with different cultural, racial, national, or religious backgrounds, and

   (e) relate to Ministry of Education curriculum guideline requirements.

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